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Water Plant Optimization Study

BELLEVILLE WATER TREATMENT PLANT

December 1990

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Water Plant Optimization Study

Belleville
Water Treatment Plant

Project No. 7-2036

December 1990

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WATER PLANT OPTIMIZATION STUDY
BELLEVILLE WATER TREATMENT PLANT

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of the Water Plant Optimization Study (WPOS) is to document and review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on the removal of particulate materials and the disinfection processes.

In striving for excellence in water treatment, it is important to examine all possible approaches, but first, optimum use should be made of the processes already in place.

This optimization study is a beginning and not an end to itself; it is the start of an ongoing documentation of the operation of the plant. It is recommended that this document be updated on an annual basis.

The Belleville Water Treatment Plant draws raw water from the Bay of Quinte, which experiences its worst water quality during the summer months when high algae counts and accompanying taste and odours occur. In recent years, the algae problem has lessened, but during the summer months, the raw water odours exceed a Threshold Odour Number (TON) of 200, and the treated water typically ranges from 20 to 50 TON. In the long-term best interest of the community, this drinking water taste and odour condition should be rectified. The overall operation of the Belleville plant is quite good, as it consistently produces water with a turbidity of less than 1.0.

In an effort to optimize particulate removal and disinfection at the Belleville Plant, this study has identified the following recommendations, recognizing that extensive renovations are to be undertaken shortly.

PHYSICAL IMPROVEMENTS

- Convert flocculation tanks to bottom entry
- Replace transmitters and recorders on two treated water meters

STUDIES

- Establish the life of the raw water flow meter
- Evaluate the merits of a streaming current monitor
- Conduct laboratory and plant-scale testing on the use of coagulant aids
- Conduct plant scale studies on the effects of flow rate on the flocculation tank performance

OTHER RECOMMENDATIONS

- The Ministry of the Environment should develop a surrogate measurement for chlorinated by-products for use in water plants in Ontario.
- Develop technology and management strategies, especially in the areas of:
  - record keeping
  - filter operation
  - filter media characterization
  - plant maintenance

A number of major capital improvements are scheduled for the plant, as outlined in the November 1986 Gore & Storrie report, entitled "Belleville Water Purification Planning Study". The following areas of concern were identified:

- Equipment in serious need of replacement, including:
  - most valves throughout the plant
  - most valve operators
  - travelling water screen
  - chlorinators
  - instrumentation
  - control systems
  - heating system
- Insufficient capacity in microstrainers - bypased when rates exceed 22.7 ML/d
- Crowded chemical storage facilities
- Deterioration of concrete in various areas
- Inadequate laboratory/office/staff facilities
- High noise levels
- Corrosion of equipment and piping
- Deterioration in the buildings

Since most of the long-term development plans would take 3 to 5 years to complete, the report suggested that the following items be addressed immediately:

- Replacement of chlorinators and associated monitoring equipment
- Replacement of chemical metering pump controls and some metering pumps
- Modifications and/or replacement of flow measuring equipment
- Modifications or replacement of low lift pump and/or engine
- Modifications and/or replacement of filter control valves and operators
- Rehabilitation or replacement of outside sump building and sump pump
- Repair or replacement of roofing on microstrainer building
- Repair leaks in walls of clearwell
- Repair concrete inlet/outlet chambers in settling tanks/mixing tanks

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WATER PLANT OPTIMIZATION STUDY
BELLEVILLE WATER TREATMENT PLANT

TERMS OF REFERENCE

The terms of reference for this report are included at the back of the report, following the appendices.

The terms of reference for the overall program have evolved during the period of this study. So as to make this report similar to later reports, we have included items which are requested in the new terms of reference and information package.

SECTION A

RAW WATER SOURCE

SECTION A
RAW WATER SOURCE

A.1 General Quality

The Belleville Water Treatment Plant is located on the north shore of the Bay of Quinte at the foot of Sidney Street. The Bay of Quinte has been the source of raw water for the community since the later 1880's.

The Bay of Quinte is a shallow body of water, and historically, the plant experiences the worst water quality problems during the summer months. The problems largely occur due to high populations of algae and accompanying taste and odours.

The Bay of Quinte and its associated watershed have been the subject of extensive water quality investigations for a number of years. The Bay of Quinte has been identified as an area of concern by the International Joint Commission. The Bay of Quinte Remedial Action Plan has identified a number of water quality problems which include nutrient enrichment, bacteriological and toxic contamination, etc. Over the last ten to fifteen years, there has been a noticeable improvement of the raw water quality entering the water plant, particularly with regard to taste and odours.

After the initiation of a phosphorus management program in late 1977, which resulted in a 50% reduction in phosphorus loading from municipal wastewater treatment plants, a decrease of about 50% in average May-October phytoplankton biomass was measured. However, in recent years (1982-1985), average May-October phytoplankton biomass increased to levels approaching those of the pre-phosphorous control period, but decreased again during 1986. As well, no major shifts in phytoplankton composition has occurred; domination by the diatoms Melosira and Stephanodiscus species and the blue-green algae Anabaena and Aphanizomenon species has continued.*

* Nicholls, K.H. and D.A. Hurley, 1987, "Recent Changes in the Phytoplankton of the Bay of Quinte: The Relative Importance of Fish and Phosphorus", Ministry of the Environment and Ministry of Natural Resources, Toronto.

A.1 General Quality (cont'd)

The raw water contains naturally occurring organics, which are precursors for trihalomethane formation. The general raw water quality parameters for the years 1983 to 1986 vary as follows:

	WINTER	SUMMER
Turbidity (FTU)	0.8-7.0	1.5-10
Colour (TCU)	10-20	10-40
Temperature (°C)	1-8	15-25
Alkalinity (mg/L as $CaCO_3$)	94-140	
Hardness (mg/L as $CaCO_3$)	104-148	
pH	7.4-8.5	7.6-8.6
Algae (ASU)	600-9000	1000-13,000
Threshold Odour (TON)	5-200	20->400

The winter period is considered to be from October to April each year. Detailed raw water quality records are provided in Appendix A.

SECTION B

FLOW MEASUREMENT

SECTION B
FLOW MEASUREMENT

B.1 Raw

Raw water flow is metered by a 610 mm (24 in.) diameter venturi meter. The raw water venturi meter generates a differential pressure, which is connected to a BIF recorder/indicator, Model No. 0259-21. This system presently has a maximum capacity of 68 ML/d (15 MIGD). The system is flushed monthly by plant staff and is calibrated every few years.

The raw meter is used for all flow records and to pace all chemical feeds in the water plant.

B.2 Treated

There are three treated water meters:

610 mm venturi meter, 0-55 ML/d capacity
406 mm venturi tube, 0-32.7 ML/d capacity
406 mm venturi tube, 0-32.7 ML/d capacity

The 406 mm venturi tubes do not have electrical transmitters, the differential pressure signal is mechanically transferred to the mercury wells and on to the recorder. One of the venturi tubes was recently cleaned and appeared to be in good condition, however, due to the age of the differential convertors and associated instrumentation, the Commission believes the flows recorded through these meters are unreliable. New transmitters for these two venturi tubes have been ordered; the mercury wells will be removed and replaced during 1988.

A Rosemount transmitter was installed in August 1987 on the 610 mm venturi meter, and sends a 4-20 mA signal to the recorder. The Commission believes this transmitter is very accurate.

B.3 Backwash

The filters are backwashed by gravity using water from a 182 m^3 (40,000 gal.) elevated backwash tank. The flow rate to the backwash tank is metered by a 125 mm Venturi, which has a capacity of 0-8.2 ML/d.

B.3 Backwash (cont'd)

The volume of water used for backwashing varies between 114-159 m^3 (25,000 - 35,000 gal.) per wash per filter. Backwash flowrate is not measured because there is no meter on the backwash line from the tank to the filters.

B.4 Filters

Each of the eight filters has a flow indicator. The individual filter rates are set manually each day, and the filter rate is varied during the day by an automatic control, based on the clearwell level. These flow meters have a capacity of 6.8 ML/d. The control systems and flow meters are unreliable and in need of rehabilitation and/or replacement.

The maximum filter rate of each filter is 6.8 ML/d. The filter rates are set individually at each filter.

B.5 Validity

The Belleville Utilities Commission believes that the raw water flow system is reliable. The meter was calibrated in 1987, and is usually calibrated once every couple of years. The Belleville Utilities Commission does not have the equipment to conduct pressure test calibrations on the flow meter transmitters, and therefore, independent companies must be brought in to conduct these tests.

Filtered water and treated water metering at the plant is unreliable and in need of rehabilitation and/or replacement.

The 610 mm venturi meter transmitter has been replaced with a Rosemount transmitter in 1987. The 406 mm venturi meters are calibrated approximately 4 times a year, using a calibration mark on the equipment. During 1988, consideration will be given to the replacement of these two treated water meters.

The per capita flow data provided in Table 1.1 of Appendix A indicate a slightly higher than normal average and maximum daily flow rates. The unaccounted-for water in the system amounts to about 22%; which, as outlined in the report entitled "Water Distribution System - 1979" by Gore & Storrie Limited, may explain these higher flow rates.

SECTION C

PROCESS COMPONENTS

SECTION C
PROCESS COMPONENTS

C.1 General

The following drawings are included in Appendix F:

(a) Site Plan, dated May 1987
(b) Block Flow Diagram, dated May 1987

This section includes detailed information on Design Data and Chemical Systems.

At present, the structural and architectural aspects of the plant are suffering from age and need considerable rehabilitation. These works are to be carried out in the near future as documented in a report entitled "Belleville Water Purification Plant Planning Study", by Gore & Storrie Limited, dated November 1986. The conclusions of this study are summarized in the Summary of Findings and Recommendations section at the front of this report.

C.2 Design Data

(a) Plant Capacity

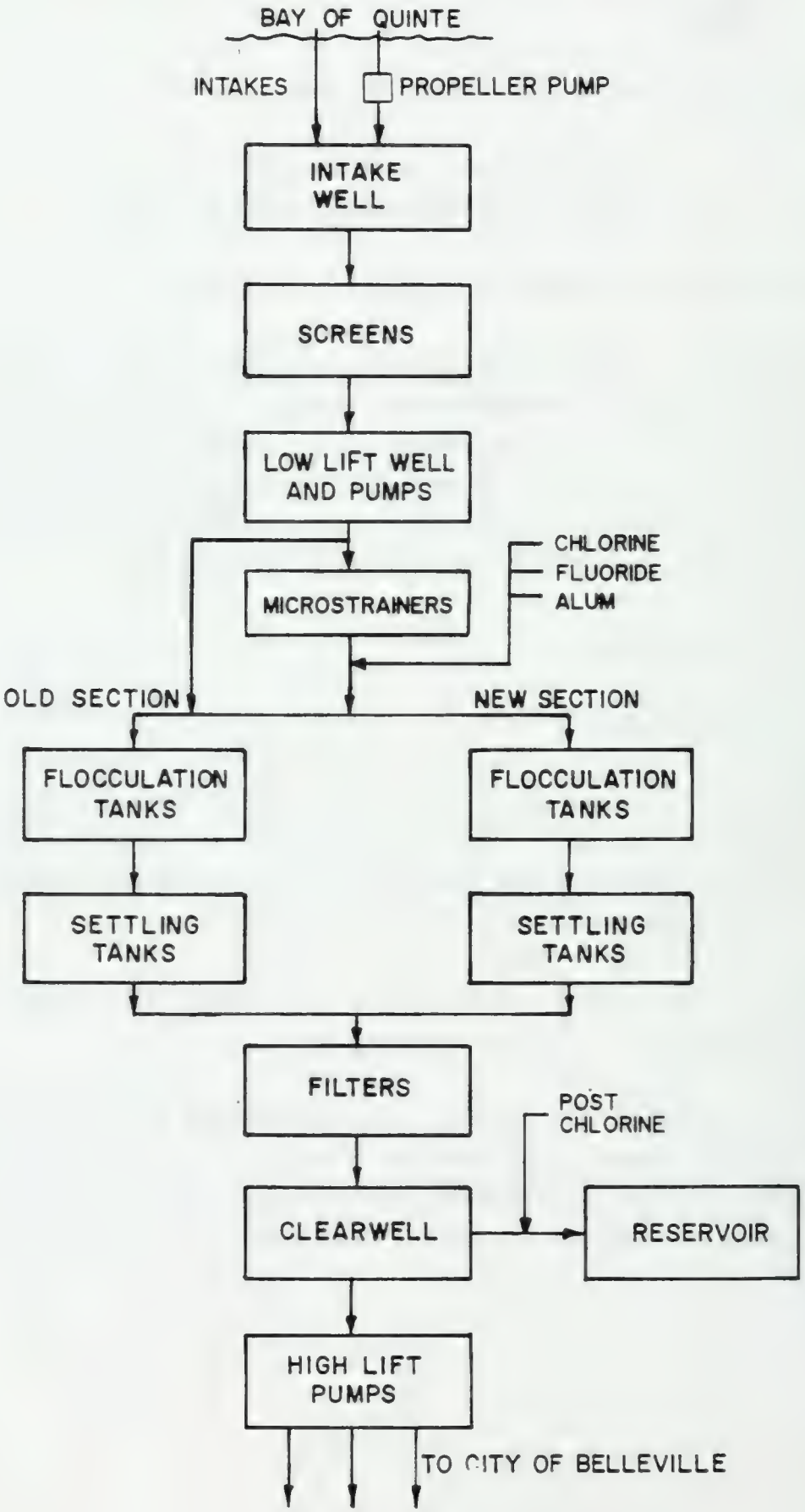
The first set of mixing and settling tanks and Filters 1-4 were completed in 1931. This is referred to as the Old Section. In 1950, Filters 5-6 were added, and in 1960, Filters 7-8 and the second set of mixing and settling tanks were constructed. The New Section includes Filters 5 to 8.

Numerous piping, pumping, process, and instrumentation changes have occurred over the years.

The plant facilities are currently rated between 45 ML/d (10 MIGD) and about 54 ML/d (12 MIGD), depending on the raw water quality and the condition of the operating equipment. The present average daily flow is about 25 ML/d (5.5 MIGD). All of the operating data presented herein are based on flows of 25 and 54 ML/d.

FIGURE I

BELLEVILLE WATER TREATMENT PLANT
PROCESS AND PIPING SCHEMATIC



(a) Plant Capacity (cont'd)

In lieu of other information, we have assumed that the total flow splits evenly between the Old and New Sections. This condition should be confirmed by field testing.

(b) Intake

The plant has two intake pipelines, as follows:

No. 1:	1923, 430 m long, 762 mm diameter steel pipe, approximate capacity of 90 ML/d.
No. 2:	1975, 490 m long, 915 mm diameter steel pipe with cement lining, approximate capacity of 136 ML/d. Water is pumped from a wet well by a 45 KW electric, vertical propeller pump. The 52 ML/d pump is manually operated and lifts water from the intake wet well to the screen chamber.

Intake No. 1 has a timber intake crib situated 1.2 m from the bottom of the bay, 3.8 m below the average water level. Intake No. 2 has a steel bellmouth intake situated near the bottom of the bay, 5 m below the average water level. This intake was the first part of a two phase program. The second phase, consisting of a low lift pumping station and chemical feed facilties, was deferred because of a proposed Regional Water Area.

In 1986 and 1987, it was established, by survey and inspection, that the intake bell on the 915 mm diameter intake, installed in 1975, has a different elevation than the "as-constructed" records. It has been established that the intake elevation is stable. The raw water quality and overall process performance are not affected by the intake location and are not affected when each of the two intakes are used on alternate days. Consequently, no action is required. Routine monitoring is ongoing to document the intake elevation and water quality.

(c) Travelling Water Screen

The intake and travelling water screen well is constructed of concrete. There is only one travelling water screen, which has cast iron supports and brass mesh with about 3 mm openings. The screen is manually operated. The intake screen facilities are scheduled for upgrading in the future works.

(d) Low Lift Pumping

The low lift suction well is concrete. The following pumps are installed:

NO.	TYPE	CAPACITY (ML/d)	HEAD (m)
1	Electric	32.7	7.62
1	Electric	41.8	8.84
1	Diesel	27.3	8.23
Total Installed		101.8	
Firm Capacity		60.0	

The firm capacity assumes the loss of the largest pumping unit.

(e) Microstraining

The microstrainer facility was installed in 1958 and consists of four units, each with a capacity of 5.7 ML/d. The total capacity is 22.8 ML/d (5.0 MIGD), which is controlled by a by-pass weir on the inlet conduit.

Microstrainers are normally used from July through November to reduce the algae load on the remainder of the plant.

The conduits and tanks are constructed of concrete. The microstrainers consist of cast iron supports with bronze gears and stainless steel screens with 35 µm mesh.

(f) Flash Mixing

The plant contains no rapid mix equipment.

(g) Flocculation

The flocculation step within the plant consists of hydraulic spiral over- and under-flow. The tanks are constructed of concrete with cast iron piping and wooden baffles.

The old section of the plant contains Tanks 1 to 18 which service Settling Tanks 1 to 3 and consist of three sets of six cells (6-stage flocculation). Each cell is 2.33 m x 2.89 m x 4.9 m deep. The total volume of the flocculation tanks is 594 m^3. Assuming a 50 percent split of flows between the old and new sections, the flocculation detention times at 54 and 25 ML/d are 32 and 68 minutes respectively.

The new section of the plant contains Tanks 19 to 26 which service Settling Tanks 4 and 5, and consist of four sets of two cells (2-stage flocculation). Each cell is 3.71 m x 3.71 m x 5.33 m deep. The total volume of the flocculation tanks is 587 m^3. Assuming a 50 percent split of flows between the old and new sections, the flocculation detention times at 54 and 25 ML/d are 31 and 68 minutes respectively.

The mixing velocity gradients in the flocculation tanks have been estimated based on a mixing energy input equivalent to the loss of momentum of the water entering the tanks. This is a conservative estimate of the total mixing, since other energy losses occur during passage of the water from one tank to another. This additional mixing energy could result in G values which are as much as 25 percent higher. The actual energy loss can be obtained from precise hydraulic tests.

Useful flocculation velocity gradients range from 100 to <10 sec^{-1}. A "tapered" or stepped series should be used; the highest mixing is provided initially, progressing through a series of cells of decreasing mixing levels. Additionally, the dimensionless parameter, Gt, which is the product of velocity gradients and the duration of mixing, is a most useful parameter which usually must have values within the range of 10^4 to 10^5.

(g) Flocculation (cont'd)

Estimated Velocity Gradient at 10°C:

Old Section	12.5 ML/d	27 ML/d
Cell 1	$G = 8.8\ s^{-1}$	$G = 27.9\ s^{-1}$
Cell 2-6	$G = 7.4\ s^{-1}$	$G = 23.6\ s^{-1}$
Overall	$Gt = 3.1 \times 10^4$	$Gt = 4.6 \times 10^4$

New Section	12.5 ML/d	27 ML/d
Cell 1	$G = 6.8\ s^{-1}$	$G = 21.7\ s^{-1}$
Cell 2	$G = 4.4\ s^{-1}$	$G = 13.6\ s^{-1}$
Overall	$Gt = 2.3 \times 10^4$	$Gt = 3.3 \times 10^4$

(h) Settling Tanks

Settling consists of concrete, horizontal cross-flow tanks, as follows:

Old Section	Tanks	1,2 & 3
	Dimensions:	22.3 m x 7.62 m x 5.41 m each
	Total Volume:	2760 m^3
	Total Surface Area:	510 m^2
New Section	Tanks	4&5
	Dimensions:	35.1 m x 7.2 m x 4.7 m each
	Total Volume:	2380 m^3
	Total Surface Area:	505 m^2

For the old section, assuming a 50 percent split of flow, theoretical detention time at 54 and 25 ML/d flows are 147 and 318 minutes, respectively. For similar flow conditions, the overflow rates are 2.2 and 1.0 m/h, respectively.

For the new section, assuming a 50 percent split of flow, the theoretical detention time at 54 and 25 ML/d flows are 127 and 274 minutes, respectively. For similar flow conditions, the overflow rates are 2.2 and 1.0 m/h, respectively.

(h) Settling Tanks (cont'd)

Settling basins No. 3 (1939) and No. 4 (1957) were inspected in June 1986. Disintegration of inlet and outlet gullets, walls, and other slabs were observed. Some baffles were missing in the mixing and settling tanks. These factors may inhibit the process hydraulics and efficiency of the settling tanks. Rehabilitation requirements have been outlined in the Planning Study Report.

(i) Filters

The plant contains eight open gravity filters, each 7.0 m x 5.5 m, which provides a total filtration area of 308 m^2 (3314 ft^2). The filter media consists of the following:

305 mm anthracite
460 mm sand
460 mm gravel

The filter tanks are constructed of concrete with cast iron piping. Filters 1 to 6 have 100 mm (4 in.) lateral underdrains, and Filters 7 to 8 have Leopold block underdrains. All filters have surface agitators.

One Lisle-Metrix DRT 285 J497B turbidity meter measures raw, filter effluent on eight filters, and tap or finished water. The turbidity meter monitors the ten stations over a 15-minute period per station. This on-line turbidimeter is checked daily against the lab operator's turbidimeter, and is calibrated once a month. This information is recorded on a strip chart.

Before each filter is backwashed, the effluent turbidity for the specific filter is recorded on a daily filter log sheet.

(i) Filters (cont'd)

OPERATING PARAMETERS

Effluent Turbidity Range (FTU)	0.17-1.00 Based on daily readings
Length of Run	50-100 hr. (Winter '85) 25-50 hr. (Summer '85)
Headloss (Max.)	1.8 m
Flow Rate	3.4 and 7.3 m/h at 25 and 54 ML/d, respectively.
Backwash Flow Rate	Summer: 35 - 50 m/h * Winter: 25 - 35 m/h *
Backwash Water/Wash	3.0-4.6 m^3/m^2

* Estimated from volume of water used and length of backwash.

(j) Clearwells

Treated water is stored in two concrete tanks, as follows:

Under Filters 1-8:	1.14 ML
On-Site Reservoir:	4.55 ML
TOTAL:	5.69 ML

The reservoir is piped directly from the filter clearwell. The filter clearwell is directly connected to the high lift pumping station.

(k) High Lift Pumping

The high lift pumping station contains the following pumps:

No.	Type	Capacity
4	Electric	15.9 ML/d (ea.)
1	Diesel	15.9 ML/d
1	Diesel	15.9 ML/d
Total Installed		95.4 ML/d
Firm Capacity		79.5 ML/d

The firm capacity assumes the loss of the largest pumping unit.

(l) Backwash Wastewater Treatment

Presently, the plant has no waste treatment facilities. The backwash water is drained directly back into the Bay of Quinte.

(m) Sludge Disposal

The settling tank sludges also drain intermittently directly into the Bay of Quinte.

C. 3 Chemical Systems

(a) Disinfectant

Chlorine gas is stored as a liquid in 0.9 tonne cylinders.

Application points:

Pre- After microstrainers (before flocculation tanks)

Post- Clearwell (not used at present for operational considerations)

Equipment:

Pre- 1 - 909 kg/d Wallace & Tiernan gas chlorinator
1 - 909 kg/d Wallace & Tiernan gas chlorinator - used for pre or post application

Post- 1 - 909 kg/d Wallace & Tiernan gas chlorinator - used for pre or post application

Scales 2 - each holds two 909 kg cylinders

The combined total feed rate from the chlorinators could be 1818 kg/d, for a total dosage of 33.7 to 72.7 mg/L for 54 and 25 ML/d, respectively.

(b) Coagulant

Liquid alum is stored in two 27,280 L steel storage tanks. One tank has a spun rubber liner and the second has a PVC bag liner.

Alum is transferred from the storage tanks to one of two 2273 L day tanks. From the day tanks a metering pump is used to pump to the application point after the microstrainers and before the flocculation tanks.

There are two metering pumps, Wallace & Tiernan series 44-126; each with a dual-head and capacity of 7.6 L/min. The maximum dosage capacity available with both pumps operating is 263 and 569 mg/L for 54 and 25 ML/d, respectively.

(c) Fluoride

Fluoride in the form of hydrofluosilicic acid is stored in one 18,180 L steel storage tank with a wound rubber liner. The acid is transfered from the storage tank to a 227 litre polyethylene day tank.

The metering pump is a 18.9 L/hr Wallace & Tiernan Model 45-050 KIE with manual stroke length adjustment for dosage and stroke speed adjustment for flow pacing from the raw water flow. The maximum dosage capacity available is 2.0 and 4.4 mg/L for 54 and 25 ML/d, respectively (provided the metering pump flow pacing [0-100%] is 0 to 54 ML/d).

The fluoride application point is after the microstrainers and before the flocculation tanks.

C.4 Photographs

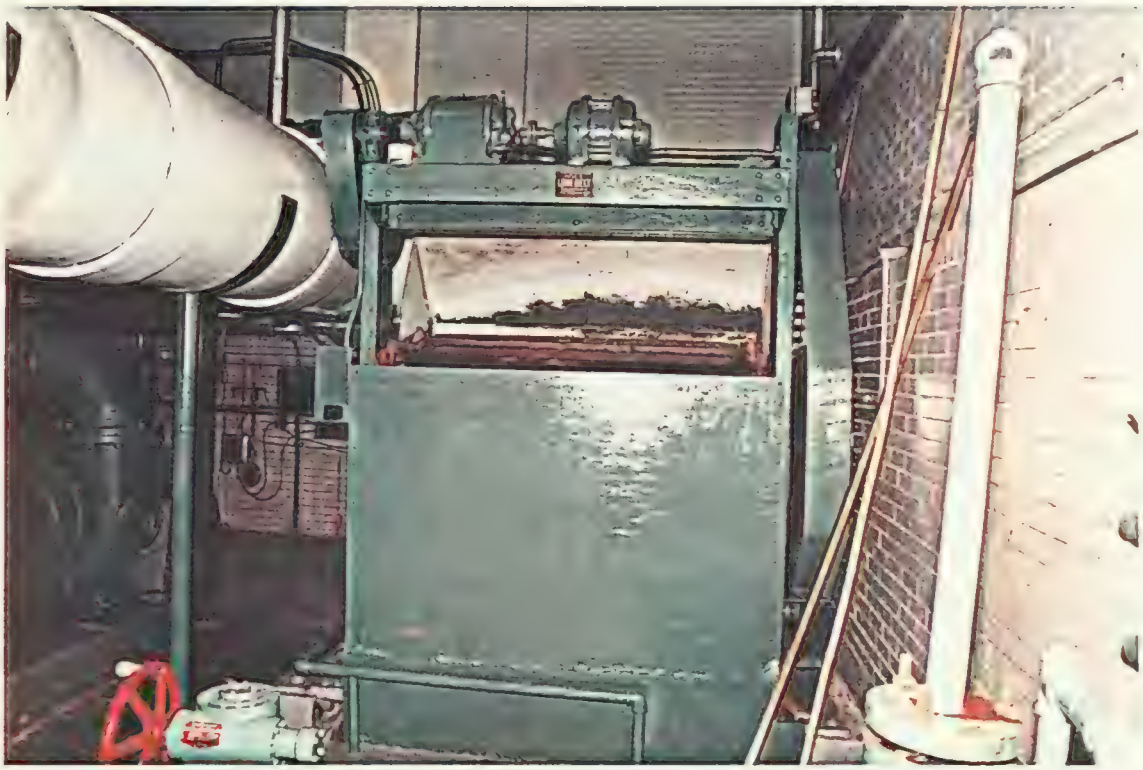
Following is a series of photographs which illustrate major components and chemical feed systems.

FILTER AND ADMINISTRATION BUILDING

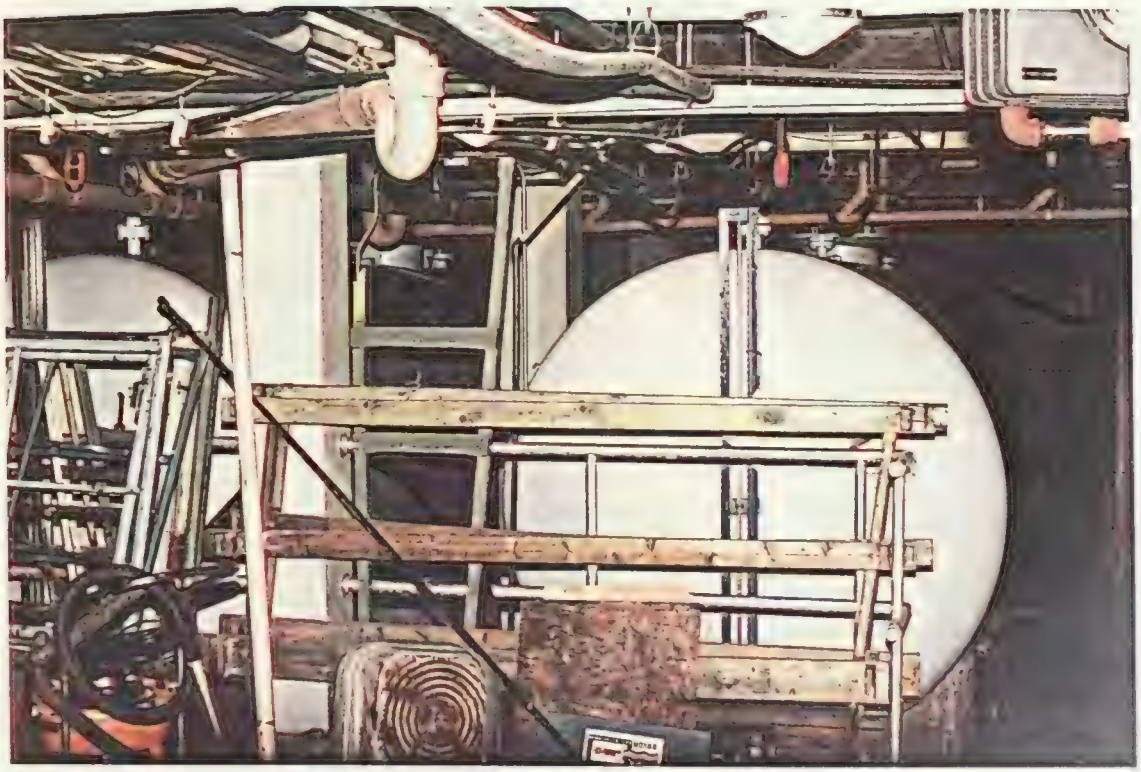
PLANT SUPERINTENDENT AND ASSISTANT

BAY OF QUINTE

INTAKE BOOSTER PUMP HOUSE



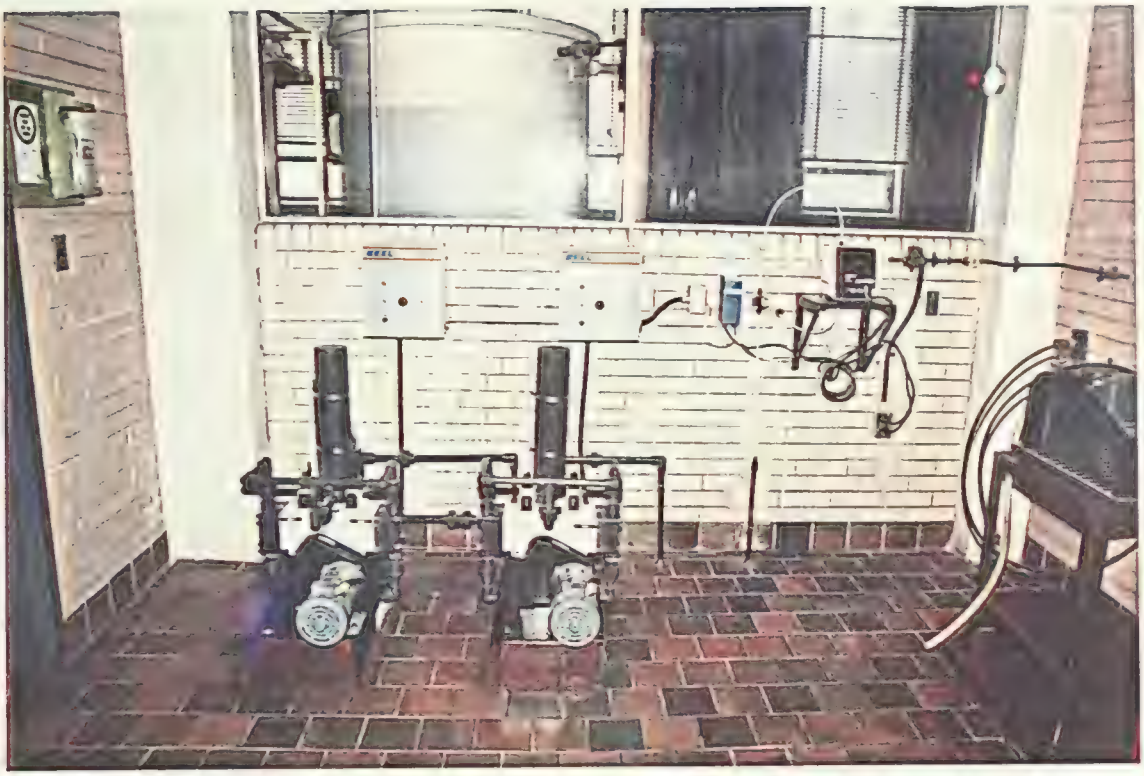
TRAVELLING WATER SCREEN



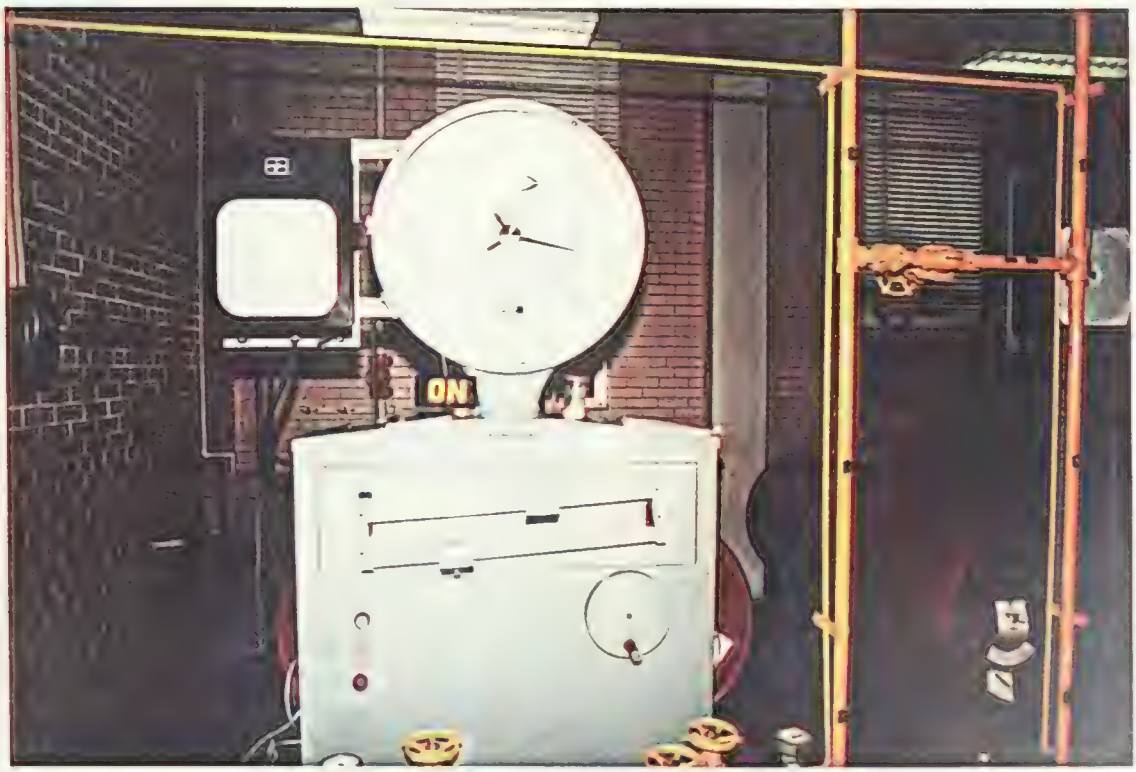
ALUM STORAGE TANKS

ALUM STORAGE TANKS AND PUMPS

ALUM AND HYDROFLUOSILICIC ACID DAY TANKS
(2 ALUM DAY TANKS, 1 SMALLER TANK FOR HYDROFLUOSILICIC ACID)

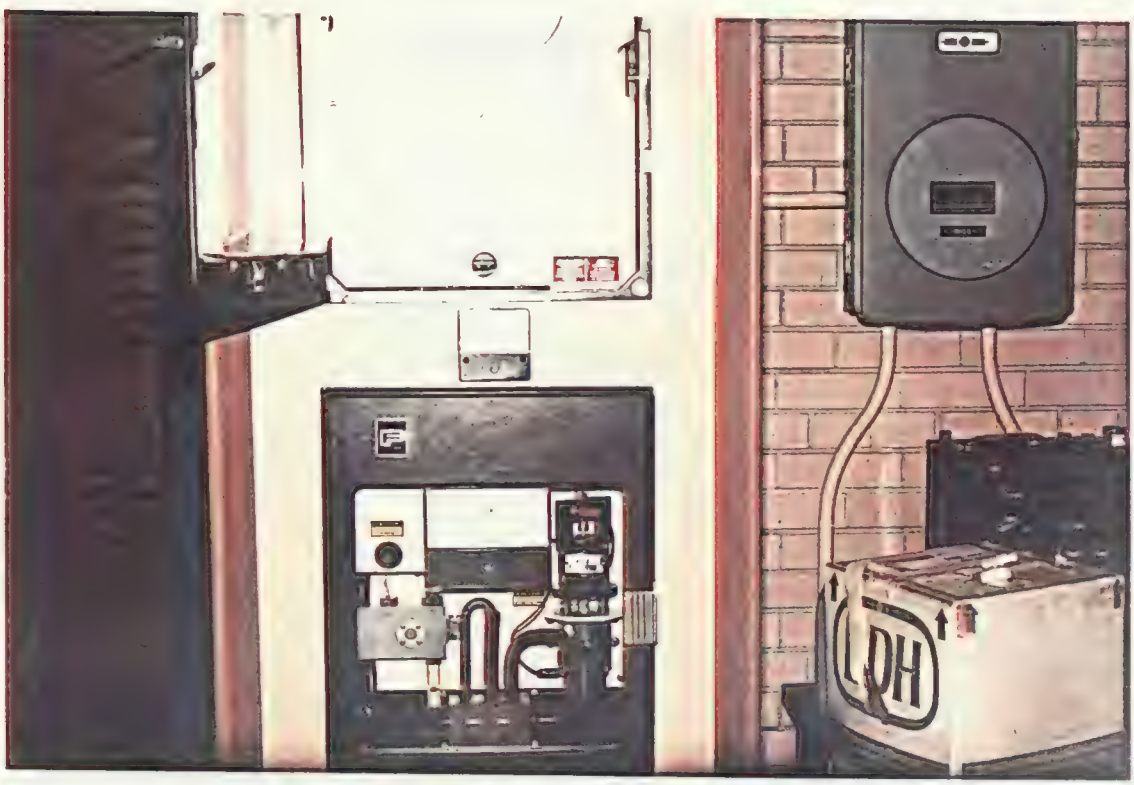


ALUM AND FLUORIDE METERING PUMPS

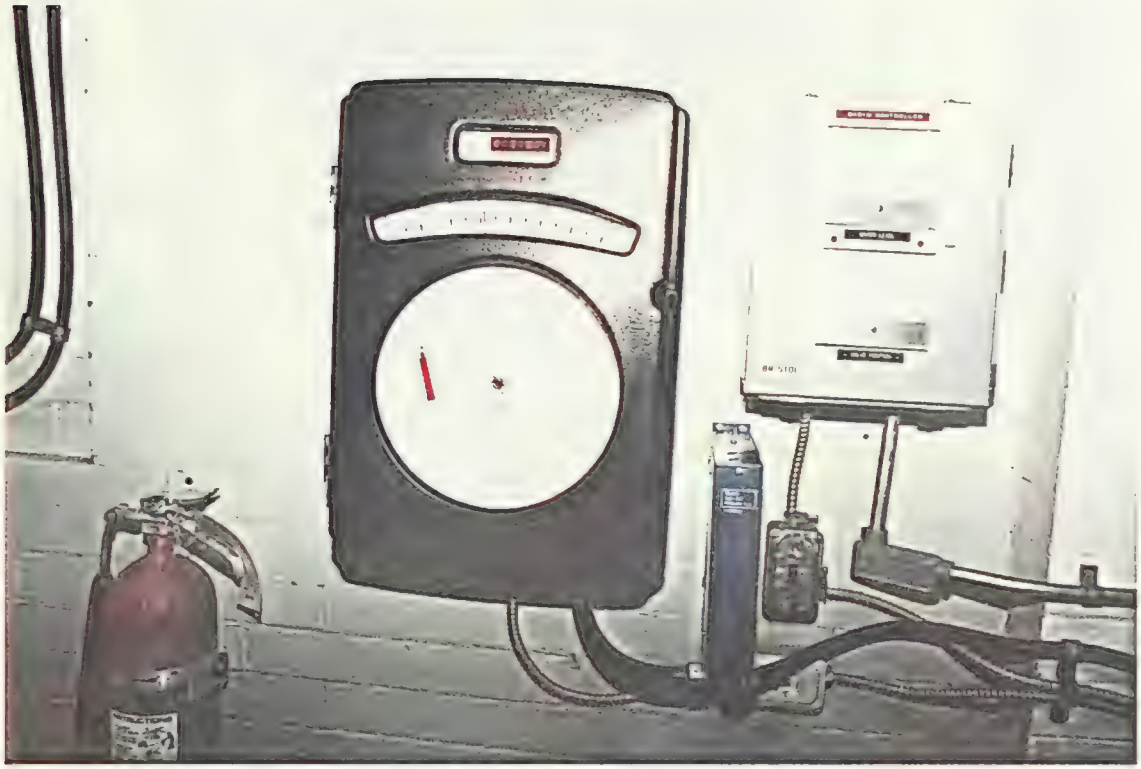


CHLORINE CYLINDER WEIGH SCALE

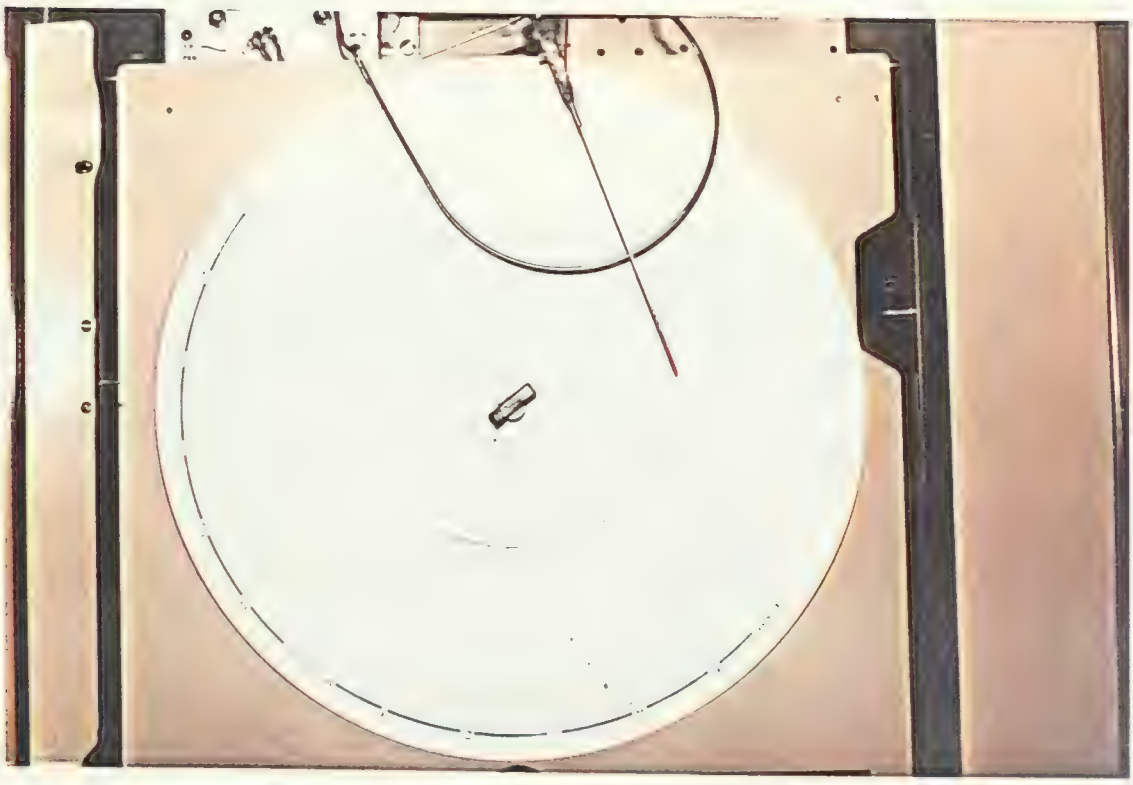
CHLORINATORS



RESIDUAL CHLORINE ANALYZER



RAW WATER FLOW CHART



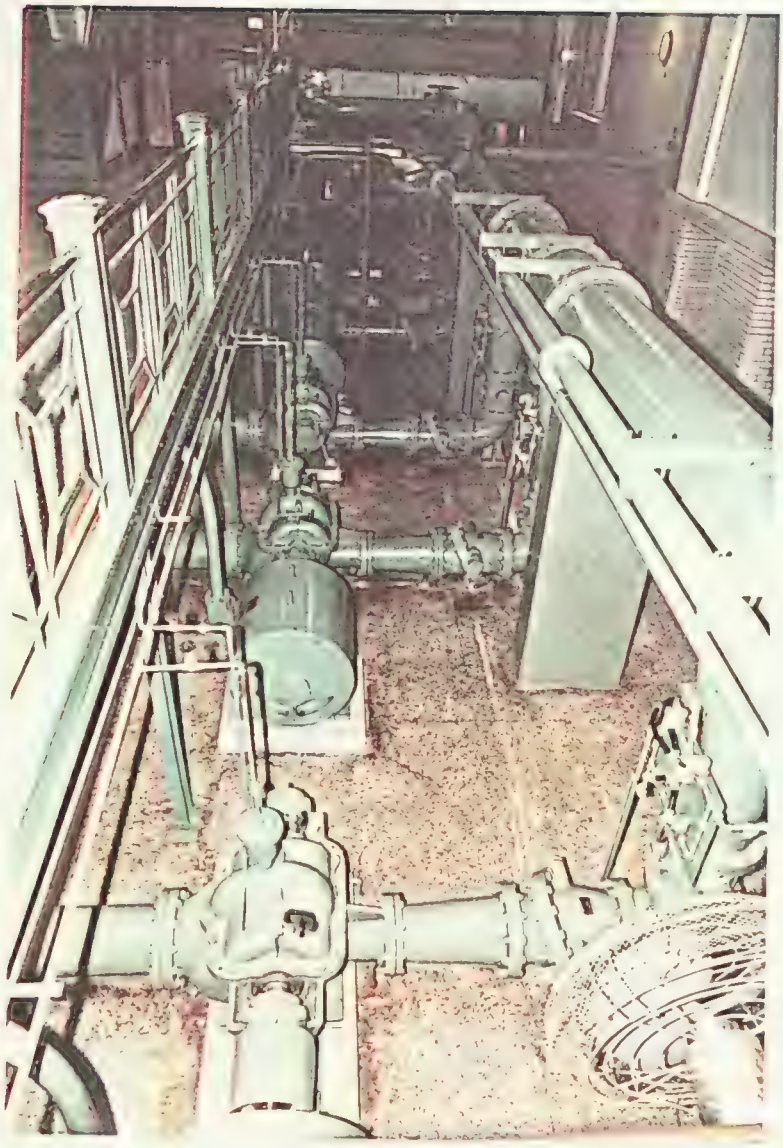
RESIDUAL CHLORINE CHART RECORDER

MICROSTRAINERS

MICROSTRAINER BUILDING

CHLORINE STORAGE

ROOF OVER FLOC AND SETTLING TANKS



HIGH LIFT PUMPS

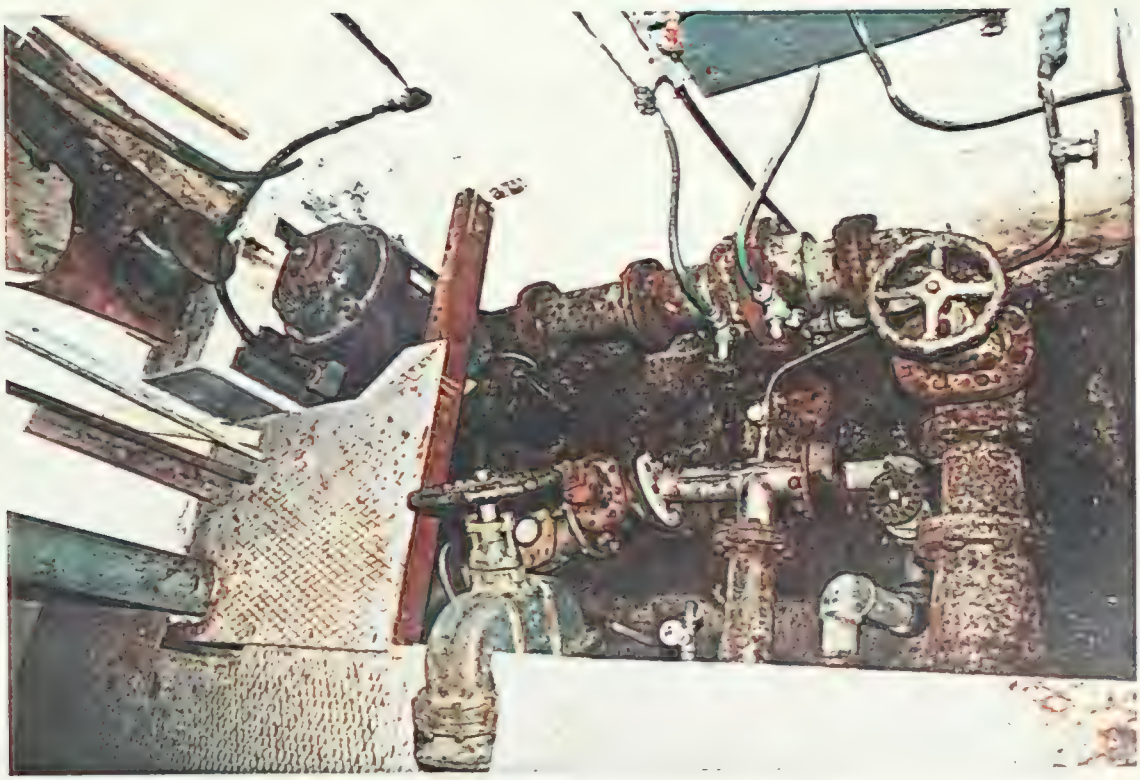
FILTER OPERATING GALLERY

FILTERS

FILTER TABLE

FILTER PIPE GALLERY

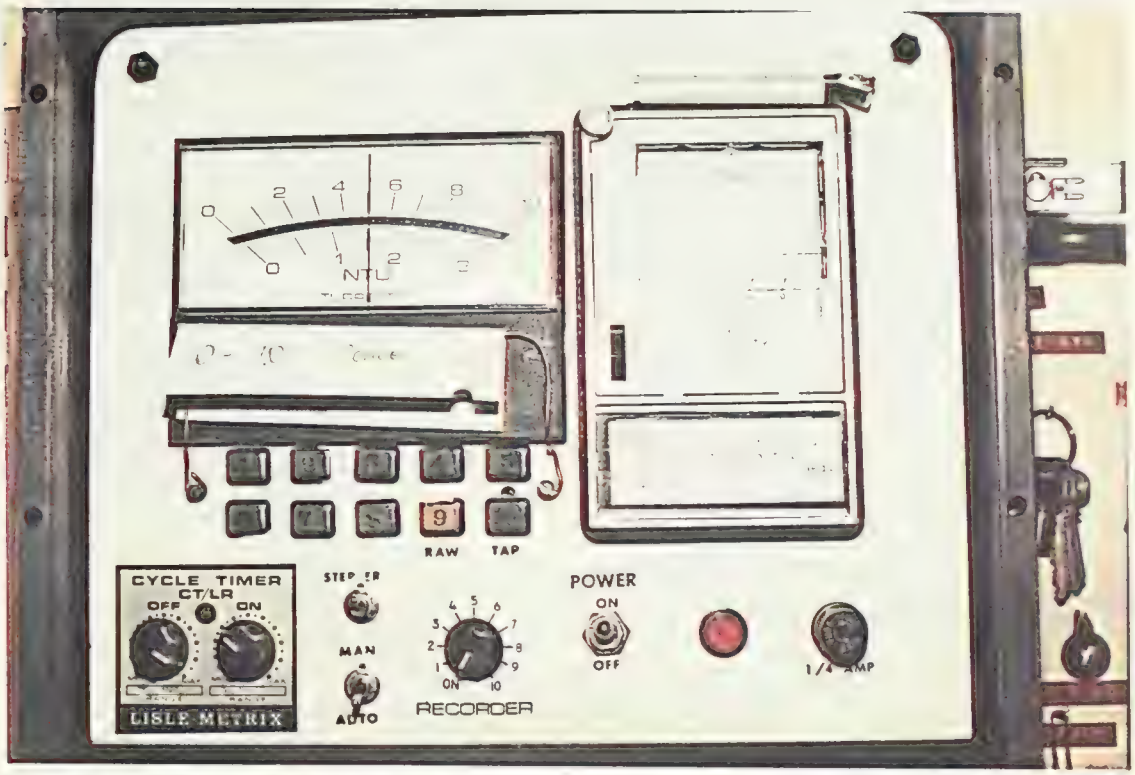
WASH WATER TANK



PUMP TO FILL WASH WATER TANK

STANDBY HIGH LIFT PUMPS (DIESEL)

RESERVOIR



ON LINE TURBIDITY ANALYZER/RECORDER
(MONITORS 8 FILTER EFFLUENTS + RAW AND TREATED)

LAB TURBIDITY METER

LAB pH METER

LABORATORY

SECTION D

PLANT OPERATION

SECTION D
PLANT OPERATION

D.1 Description

(a) General

The plant was originally constructed in 1931, with expansions in the 1950's. Numerous piping, process and instrumentation changes have occured over the years. As documented in a report prepared by Gore & Storrie Limited, entitled, "Belleville Water Purification Plant Planning Study" dated 1986, the plant is in need of major rehabilitation, modifications and additions. The findings of this report are outlined in more detail in Section D.2. These changes to the plant commenced in 1987, with a possible completion by 1992. Therefore, many of the present operational conditions are subject to changes in the near future.

(b) Flow Control

RAW WATER

The plant production flows are determined by the measurement of the raw water flow, which is modulated by a control valve to maintain a settled water level.

PRETREATMENT AND SEDIMENTATION

Each section of the plant is fed with water in a manner dictated by the plant hydraulics. It has been assumed for the purposes of this report that the flow split is about equal to the old and new sections of the plant.

All flocculation and sedimentation tanks are used all of the time, except during periods when the settling tanks are cleaned.

(b) Flow Control (cont'd)

FILTRATION

The filter rates are set manually. At present, filter rate selection is accomplished from experience, since the filter flow instrumentation is quite poor. Normally all of the filters operate all of the time.

HIGH LIFT PUMPING

High lift pumps are selected to maintain the plant discharge pressure at 560 kPa (80 psi) minimum. Depending on the number of high lift pumps, filter rates are set manually, and low lift pumps are selected to keep pace with the filters.

(c) Filter Backwashing

The criteria used to initiate a filter backwash is either headloss, time or turbidity, but backwashing has never occurred because of high turbidity.

The Belleville Water Treatment Plant has a 180,000 L elevated washwater tank. The tank is filled with a 4500 L/min. pump, and the flow into the tank is metered with a 125 mm venturi meter. Belleville also has an auxillary wash system, in which the high lift pumps are used and water is taken from the 600 mm main treated water header. This system is seldom used.

The normal backwashing procedure at the Belleville plant consists of closing the influent and effluent valves and operating the surface agitators for 5 to 6 minutes. The water from the washwater tank then backwashes the filter for 5 to 7 minutes. During the winter months, approximately 115,000 L/wash is used, and during the summer months, approximately 160,000 L/wash is used. The backwash operation should be optimized in the immediate rehabilitation works for the plant.

(c) Filter Backwashing (cont'd)

The filters are normally washed after a period of 25 to 50 hours during the summer months, and during winter, this time is extended to 50 to 100 hours. If the headloss on any filter reaches a maximum of 1800 mm, it is washed regardless of the number of hours in service. The filter effluent turbidity is entered into the operating log just prior to backwashing.

The wash rates of 25, 35, and 50 m/h provide bed expansions of approximately 8%, 19%, and 35%, respectively, at 15°C. As noted earlier, the volume of water used during a backwash is 3.0 to 4.6 m^3/m^2. Our experience indicates that a wash volume of 4.0 - 5.0 m^3/m^2 should properly clean a filter bed.

(d) Chemical Dosage Control

Alum, fluoride, and chlorine are introduced, after the microstrainers and before the flocculation tanks, into an open conduit.

ALUM

Jar tests have not been used for many years; rather, historical operating knowledge is used. Presently, adjustments are made to alum dosage, based on experience and observation of water on top of the filters.

Historical information on jar tests indicated that jar test results typically showed higher dosages than actually required in the plant. For example, a 40 mg/L jar test result required a 30 mg/L plant dosage.

Alum dosage is set at the metering pump by manual stroke adjustment, and the metering pump speed is flow-paced from the raw water flow meter. Daily alum usage is determined by measuring level drop in the active alum day tank. The dosage is computed for the daily alum usage and the daily raw water flow rate. This method should provide accurate dosage values, since the tank level drops approximately 100 cm/day at a plant flow of 25 ML/d.

(d) Chemical Dosage Control (cont'd)

The Belleville plant changed from a liquid alum and dilution water feed system, to feeding only liquid alum in early 1987. A new chemical metering system was installed in 1987, and the Commission believed that more accurate chemical flow pacing could be achieved by feeding only liquid alum. The alum feed system should be investigated in the first annual report.

CHLORINE

Pre-chlorination is used to attain the following residuals in the plant at the last flocculation cell before the settling tanks:

SEASON	CHLORINE RESIDUAL (mg/L)	
	Free	Total
Summer	2.0	2.4
Winter	1.6	2.0

These residuals are measured once every three hours

The above residuals are usually enough to ensure a 1 mg/L total chlorine residual is maintained in the water going to the city.

Once per day, free and total chlorine residuals are measured at three places in the plant:

- Last flocculation cell
- Top of filters
- Tap or finished water

The finished water total chlorine residual is measured once every hour. Chlorine residuals are determined with a Fisher & Porter laboratory amperometric titrator. The plant effluent free chlorine residual is continuously analyzed with a Fisher & Porter continuous chlorine analyzer.

Pre-chlorination is paced from the raw water flow. Closed loop control is not used. Presently, due to operational considerations, post-chlorination is not used. Since the dissolved organics in the raw and treated water are high, the associated chlorine demand is high. The need for disinfection dictates the chlorine dosage. Thus, the levels of trihalomethanes formed are controlled by the chlorine concentration rather than being limited by the presence of precursors.

(d) Chemical Dosage Control (cont'd)

Daily confirmation of total chlorine used is by weight loss from the active cylinder. The chlorine weight reading is taken every 24 hours.

FLUORIDE

Fluoride is added to the water using hydrofluosilicic acid. The acid is fed from a 227 kg day tank on a weigh scale, using a metering pump that is manually set, and flow-paced from the raw water flow. Daily hydrofluosilicic acid usage is determined by recording total weight loss from the day tank every 24 hours.

Fluoride residual determinations are done on a daily basis, using a Spadns wet chemistry technique.

(e) Quality Control Testing

SOURCE	LENGTH SIZE (m/mm)	FLOW (L/min)		VELOCITY (m/s)		TRAVEL TIME (min.)	
		Max.	Norm.	Max.	Norm.	Min.	Norm.
Last flocculation chamber in old section of plant	13.7/12.7	-	0.833	-	0.09	-	2.5
HL main to operator's lab	3.7/50.8 & 12.7	-	0.833	-	0.09 & 0.005	-	1.6
HL main to plant lab	9.6/9.5 & 12.7	-	0.833	-	0.09 & 0.15	-	1.7

The sample line from the last flocculation chamber is gravity fed to a drain in the filter gallery. Operators take samples for analysis from this line.

The sample line from the high lift main splits into two branches. One goes to the operator's lab, the other to the plant lab. These lines run continuously.

(e) Quality Control Testing (cont'd)

The sample line from the last mixing chamber is constructed of polypropylene. The sample line from the high lift main to the plant lab is made of copper. The sample line from the high lift main to the operator's lab has 5.9 m of copper pipe, 2.4 m of galvinized steel and 1.2 m of copper tubing. There are two stainless steel DWSP sampling lines; one raw water line runs from the raw water well to the lab, and one treated water line runs from the clearwell to the lab.

There are 10 sample lines leading to a Lisle-Metrix DRT285 J497B continuous turbidity meter, eight lines from the filter effluents, one from raw and one from finished. These sample lines are made of plastic tygon tubing. The meter itself is located in the filter gallery with a remote strip chart recorder in the operator's lab. Plant staff feel that this meter is unreliable and do not depend upon it for any operational duties, nor are the results recorded in the daily log.

IN-PLANT MONITORING

The following table gives a list of the tests performed at the plant:

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT
Cl_2 Residual				
- Free, Total	Last mixing chamber in old section of plant	1/day	1/day	Fisher & Porter Amperometric titrator
- Free, Total	Last mixing chamber in old section of plant	1/3 hours	1/3 hours	Fisher & Porter Amperometric titrator
- Free, Total	Grab sample from top of filter 5	1/day	1/day	Fisher & Porter Amperometric titrator
- Free	HL discharge	1/day	1/day	Fisher & Porter Amperometric titrator

(e) Quality Control Testing (cont'd)

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT
- Total	HL discharge	1/hour	1/hour	Fisher & Porter Amperometric titrator
- Free	Plant Effluent	Continuous	Continuous	Fisher & Porter Continuous Cl_2 Analyzer (checked daily)
Turbidity	8 filter effluents, 24" finished water-main, raw water well	Every 15 min. for each location	Noted on wash records each time a filter is washed	Lisle-Metrix (DRT 285 J497B) (checked daily, calibrated monthly)
	HL discharge and Raw Water Well	1/day	1/day	HF Instruments DRT 100 (calibrated daily)
pH	HL discharge and raw water well	1/day	1/day	Corning pH meter
Bacteriological Testing	HL discharge and raw water well	1/week	1/week	*
Colour	HL discharge	1/day	1/day	Hellige Colorimeter
TON (Threshold Odour Number)	HL discharge raw water well	1/week	1/week	
Fluoride	HL discharge Raw Water Well	1/day	1/day	Spadns Wet Chemistry Method
Algae Counting	Raw water well	1/week from Mar. - Nov. No testing carried out rest of year	Each count is reported on daily log	Microscope/ Whipple eyepiece appartus
Water Temp.	Raw water well	1/day	1/day	Thermometer

* Samples are sent to the MOE lab in Kingston for analysis. Additional bacteriological tests are conducted as part of the DWSP program.

(f) Validity of Data

The water quality results presented in Table 5.0 and 5.1 in Appendix A were obtained from a MOE testing program.

In Table 5.0, where measurements were available, the values were analyzed and recorded as Max., Min. and Avg. This could be completely misleading as the numbers recorded in Table 5.0 are only the Max., Min., and Avg. of the various grab samples taken. The numbers recorded therefore do not represent the Max., Min. and Avg. for even a daily set of data.

Extreme caution must be exercised when using the data presented in Table 5.0.

One observation noted during our review of Turbidity data in Table 5.0 vs Turbidity data recorded at the plant is that:

> Table 5.0, page 3 of 18, shows a Max. treated water turbidity of 2.2 in 1985 whereas, Table 2.0, page 3 of 4, shows a Max. treated water turbidity of 0.78 in July 1985.

Another observation shows that:

> Table 5.0, page 3 of 18, records a Max. raw water turbidity of 6.1 in 1985; whereas, Table 2.0, page 1 of 4, records a Max. raw water turbidity of 27.0 in March 1985.

These examples are representative of how misleading the tabular information can be unless the exact basis and frequency of measurements is understood.

Reference was made at the site visit regarding the comparison of MOE and plant fluoride residual measurements. The table below documents the residual measurements made in 1985. The daily average fluoride dosage data are based on the 24 hour fluoride usage divided by the flow and, therefore, represent a 24 hour time weighted average. Both fluoride residual measurements are grab samples.

(f) Validity of Data (cont'd)

COMPARISON OF RESIDUAL FLUORIDE MEASUREMENTS

Date	Daily Average Fluoride Dosage (mg/L)	Belleville WTP Fluoride Residual (mg/L)	Regional MOE Fluoride Residual (mg/L)
8 Jan. 85	1.28	1.24	1.1
5 Feb. 85	1.28	1.16	1.1
5 Mar. 85	1.38	1.20	0.7
2 Apr. 85	1.31	1.18	1.1
7 May 85	1.31	1.22	1.1
4 June 85	1.36	1.19	1.35
2 July 85	1.25	1.18	N/A
6 Aug. 85	1.19	1.17	1.0
3 Sep. 85	1.12	1.17	0.94
1 Oct. 85	1.21	1.24	0.85
5 Nov. 85	1.23	1.24	1.1
4 Dec. 85	1.20	1.08	0.9

Except for the 5 March, 3 September and 1 October fluoride residuals, the Belleville Water Treatment Plant and MOE Regional Office measurements are within ±10% of one another. Although this may not be what is expected in detailed analytical work, considering the transportation of the Regional samples and any other delays before the tests are conducted, the recorded results are within engineering tolerances. It should also be noted that the Regional Office measurements are usually recorded to 2 significant figures, while the Belleville Water Treatment Plant results have 3 significant figures.

Overall, tabulated data in Appendix A provides a fair representation of the plant operation.

D.2 Operation and Process Concerns

A planning study was completed in November 1986 by Gore & Storrie Limited for the Belleville Utilities Commission. The planning study identified the following areas of concern:

(a) Facilities

- Equipment in serious need of replacement, including:

  - most valves throughout the plant
  - most valve operators
  - travelling water screen
  - chlorinators
  - instrumentation
  - control systems
  - heating system

- Insufficient capacity in microstrainers - bypassed when rates exceed 22.7 ML/d

- Crowded chemical storage facilities

- Deterioration of concrete in various areas

- Inadequate laboratory/office/staff facilities

- High noise levels

- Corrosion of equipment and piping

- Deterioration in the buildings

The above problems have not yet manifested themselves in the overall process performance. Most of the problems are a result of deterioration due to age and the result of postponing capital improvements.

(b) Water Quality Concerns

The major process problems facing the plant are in dealing with taste and odour problems and trihalomethanes. Occasionally, the colour exceeds the water quality guidelines.

SECTION E

PLANT PERFORMANCE (PARTICULATE REMOVAL)

SECTION E

PLANT PERFORMANCE (PARTICULATE REMOVAL)

E.1 Turbidity Removal

(a) General

The Belleville plant must deal with winter and summer raw water quality conditions as shown:

	WINTER	SUMMER
Turbidity (FTU)	0.8-7.0	1.5-10
Colour (TCU)	10-20	10-40
Iron (mg/l)	0.01-0.30	
Manganese (mg/L)	0.003-3.5	
Algae (ASU)	600-9000	1000-13,000
Temperature (°C)	1-8	15-25
Threshold Odour	5-200	20->400

Considering turbidity alone, the raw water quality conditions would allow treatment by direct filtration (that is, a plant without settling tanks) to meet today's treated water turbidity objective.

Raw water turbidity removal is not a critical issue for the Belleville plant. Rather, algae, taste and odour, and trihalomethanes are the more important parameters.

(b) Plant Performance

OVERALL PLANT PERFORMANCE

It is usual to consider two conditions for plant operation, the maximum hydraulic flow rate and the maximum process flow rate. The maximum process condition, from the stand point of particulate removal, occurs with the highest solids loading on the plant. The maximum flow and worst raw water quality can be coincident at this plant. The flow in any year only varies about 3:1, while the raw water solids and corresponding solids generated within the process can vary about 30:1; therefore, the maximum process condition corresponds to the combined worst water quality and highest flow rate conditions.

In the period from 1983 to 1986, the maximum day demand occurred in July or August. It is during this summer period when the raw water conditions are at their worst.

Daily turbidity readings were recorded for August and September 1985, and July, August, and September 1984, to study the effects of raw water turbidity on the plant's performance. The turbidities are recorded in Tables 2.1 to 2.5 in Appendix A.

The same data are presented graphically in Figures 2.1 to 2.5 in Appendix B.

Figure 2.3 shows a period of rising raw water turbidity and the resulting rising treated water turbidity. The maximum treated water turbidity rose to 1.0 NTU on 27 July 1984. This same day, the raw water turbidity peaked at 9.4 NTU.

The recorded alum dosage on 27 July 1984 was 25.7 mg/L. Dosages on the 26th and 28th were 29.9 mg/L and 34.2 mg/L, respectively. The raw water turbidity was slightly lower on both the 26th and 28th than the peak turbidity of 9.4 NTU on the 27th. It can be concluded that one factor leading to the treated water turbidity of 1.0 NTU on 27 July 1984 was a low alum dose.

(b) Plant Performance (cont'd)

By example, Table 2.4 for 10 August 1984 shows a raw water turbidity of 9.5 NTU, received 42.8 mg/L of alum, and the resultant treated water turbidity was 0.58 NTU. Figure 2.4 in Appendix B shows the same results graphically. Figure 2.4 demonstrates that, when higher raw water turbidities were treated with higher alum dosages, the treated water turbidities were maintained well below 1.0 NTU.

PERFORMANCE WITH POLY ALUMINUM CHLORIDE

In the period from 5 March 1986 through to 12 May 1986 the Belleville plant ran a full scale trial operation using STERNPAC or Poly Aluminum Chloride (PAC) as a coagulant instead of Alum.

Tables 2.6 - 2.8 in Appendix A show the Particulate Removal Profiles for the March through May 1986 period when PAC was being used. For comparison purposes Tables 2.9 - 2.11 show the Particulate Removal Profiles for the March through May 1985 period when Alum was being used.

A review of the performance with PAC in 1986 to Alum in 1985 shows:

DOSAGE (mg/L)					
PAC (1986)			ALUM (1985)		
Max.	Min.	Avg.	Max.	Min.	Avg.
23.6	7.0	9.7	45.2	24.2	32.9

In the same periods the raw and treated water turbidity varied as follows:

	TURBIDITY RANGE (FTU)					
	Mar. - May 1986			Mar. - May 1985		
	Max.	Min.	Avg.	Max.	Min.	Avg.
Raw	41.0	0.5	2.9	27.0	1.0	2.4
Treated	0.90	0.17	0.37	0.49	0.27	0.38

Poly Aluminum Chloride was tested over approximately a two month period between 5 March and 12 May 1986. The average PAC dose was 9.7 mg/L compared to the average Alum dose of 32.9 mg/L for the same period a year earlier.

(b) Plant Performance (cont'd)

It is obvious that the PAC dosage used was only about 30% of the Alum dose and the average treatment effected was approximately the same with both chemicals.

At the present time (PAC) STERNPAC is approximately three times more expensive than Alum in Southern Ontario. Therefore, unless the required PAC dosage is less than one-third of the required Alum dosage, the PAC is not economically justified.

In some reported instances, PAC dosages of less than one-third the required alum dosage actually produce a better quality end product with less sludge and at a lower cost. However, while the 1986 PAC trial at the Belleville plant did demonstrate a marginal cost advantage, no significant performance improvement was noted but colour was not effectively removed.

E.2 Treatability Testing

(a) Jar Testing

TURBIDITY REMOVAL

Treatability testing was carried out on two raw water samples with 4.0 and 12.5 NTU, respectively. The results are included in Appendix C.

Alum and various polymers were used in the coagulation/flocculation/sedimentation testing, followed by filtration through a 1.2 µm membrane which, in our experience, emulates the performance of a dual media filter. The results of the testing demonstrate that filtration down to a turbidity of 0.16 NTU is achievable for both samples tested, providing appropriate dosages of alum plus a coagulant aid are used.

As discussed above, laboratory scale testing indicates that, under ideal conditions, the raw water particulate materials can be coagulated so as to yield low filtered water turbidities. In addition, the plant operating data

show that episodes of higher filter effluent turbidities result from higher turbidity conditions, wherein the alum dosage may be less than needed.

It is Gore & Storrie's opinion that additional testing should be carried out by the plant staff to ascertain the relative merits of specific polyelectrolytes to reduce the filter effluent turbidities. Clearly, the improved performance must be gauged against the increased costs of operation.

ALUMINUM RESIDUAL

The use of aluminum salt coagulants (alum, polyaluminum chloride, etc.) in potable water treatment plants may lead to increased aluminum concentrations in treated water, which may result in water quality and supply problems.

There is no evidence that aluminum is physiologically harmful, and no health-related limit has specified anywhere in the world to our knowledge. However, the perception of potential health problems associated with aluminum frequently emerges.

Water supply problems may be associated with increased aluminum concentrations in treated water. These problems include the formation of a hydrous aluminum precipitate in the distribution system which may increase turbidity and complaints about clarity. Aluminum floc in the system may interfere with the disinfection process by entrapping and protecting microorganisms. Another problem attributed to increased aluminum concentrations is deposition of aluminum hydrolysis products on pipe walls, which decreases carrying capacity. To minimize these problems, the Ontario Drinking Water Objectives (ODWO) suggest an operational guideline of <0.1 mg/L as Al in the treated water leaving the plant.

An EPA survey of 186 utilities showed that a number of plants exhibited high residual aluminum when overdosing of alum occurred. Even though some utilities surveyed stated that minimizing the alum dosage is a strategy for controlling residual aluminum, underdosing of alum appears to be just as detrimental to turbidity removal and residual aluminum control as overdosing.

(a) Jar Testing (cont'd)

Water quality problems associated with high concentrations of aluminum in finished water have led to discussion of ways to reduce residual aluminum concentrations. One method of reducing aluminum concentration is to optimize coagulation. To have optimum coagulation requires that the best coagulant, dosage, and combination of operating conditions be selected for each raw water. The optimum pH range must also be achieved since aluminum is least soluble in water in the pH range 5.5-7.0.

There are tretment plants in Ontatio which are currently using residual aluminum as an "operating tool" to optimize the dosage of alum. Operational staff respond to any elevation in residual aluminum and make the necessary adjustments to the plant operation.

Aluminum solubility in water is a complex topic; but some of the most significant variables are pH, time and temperature. For pH values greater than 6.5, the aluminum residual increases directly with pH. Aluminum residual is inversely proportional to time, up to several hours, whereupon the solubility concentration remains fairly constant. The aluminum residual is directly related to temperature, but this has a fairly minor impact over the ranges encountered in natural waters. For times greater than an hour and pH's greater than about 7.4, water may contain a residual concentration greater than 0.1 mg/L.

For the aluminum residuals and pH values found in the waters at the plant, the results are consistent with general experimentally determined values. Therefore, it is not surprising to find aluminum concentrations greater than 0.1 mg/L.

Belleville's treated water aluminum residuals have sometimes been above the guideline of 0.1 mg/L, therefore, jar tests were run to check aluminum residual. In Gore & Storrie's opinion, the benefits associated with changing the alum dosage to control the aluminum residual, over and above those for turbidity control, is not warranted.

(a) Jar Testing (cont'd)

A minimum of daily monitoring of aluminum residual and pH leaving the plant is recommended by the Ontario Ministry of the Environment. An acceptable method of aluminum analysis should be used. Frequent examination of this data and Drinking Water Surveillance Program (DWSP) data will supply the needed information on the chemistry and fate of aluminum following water treatment to help operating authorities minimize the concentration of aluminum in the treated water.

COAGULANT(S) DOSAGE

From the laboratory testing conducted by Gore & Storrie Limited, it appears that a minimum alum dosage of 5 to 15 mg/L is required. The best filter effluent quality was obtained with 10 to 15 mg/L of alum and 0.3 mg/L of an anionic polymer. The conclusion is that a polyelectrolyte is required to ensure the lowest possible filtered water turbidity.

(b) Streaming Current Monitor

It was stated earlier that, during a period of rising raw water turbidity in July 1984, the treated water turbidities also rose to a peak of 1.0 FTU. The alum dosages during this same period were being adjusted up and down in an attempt to achieve the optimum performance. A streaming current monitor (SCM) may allow a faster and more accurate response for the selection of the correct coagulant dosages.

We recommend, in the absence of better information, such as streaming current monitoring data, that during periods of rising raw water turbidities, alum dosages from previous operating logs be used to assist in establishing the correct alum dosage for the current condition.

Further, a streaming current monitor trial should be initiated.

E.3 Optimum Removal Strategies

(a) Flocculation Mixing and Sedimentation

As noted in previous sections, all the flocculation and sedimentation tanks are used at most times. Since the level of mixing in the flocculation tanks is dictated by the flow rate, there may be some marginal benefits obtained from isolating the pretreatment sections of the plant. The resident time afforded by having all tanks operational is increased at lower flows; thus the mixing system tends to compensate for the reduced flow rates. In addition, the settling tank performance is inversely dependent on the flow rate; therefore, this unit operation tends to also compensate for reduced mixing levels at lower flow rates by becoming more efficient. Clearly, there are bounds to how low the flow rate can be before overall performance is effected, but this should not be experienced at this plant.

It is our opinion that, at this time, there is no merit to investigating the improvement which would result from maintaining high flows in the flocculation tanks. We believe that the performance improvements will only be small and that major changes are being considered for the plant in the near future.

(b) Filtration

All of the filters are run all of the time when the plant is producing water, and the maximum filtration rates are set by the operator as dictated by the system demand. The lower the filtration rate, the better the removal performance; which can be achieved by operating all filters all the time. Therefore, from the standpoint of particulate removal, the ideal procedure is exactly as is done; which is to operate all filters with a constant flow rate to satisfy some long-term demand. This procedure requires that the clearwell level rise and fall to offset the difference between production and demand flow rates.

Filter effluent particulate monitoring can be achieved with individual filter effluent turbidimeters. These will be included as part of the immediate rehabilitation works.

SECTION F

PLANT PERFORMANCE (DISINFECTION)

SECTION F
PLANT PERFORMANCE (DISINFECTION)

F.1 Disinfection

At the Belleville Water Treatment Plant, disinfection is carried out by pre-chlorination at a point between the microstrainers and the flocculation tanks. Fluoride and alum are also added at this point.

Sufficient chlorine is added to maintain total residuals of 2.4 mg/L (2.0 mg/L free chlorine) in summer and 2.0 mg/L (1.6 mg/L free chlorine) in winter. Post-chlorination is not practised at present.

The amount of chlorine applied is sufficient to provide a total residual of approximately 1 mg/L leaving the Belleville plant. Data from Tables 3.0 - 3.1 in Appendix A show that the average chlorine dose is 3.6 mg/L for 1983-86 and that the monthly average chlorine dosages ranges from 2.3 to 5.1 mg/L.

F.2 Disinfection Efficiency

Tables 7.0 to 7.3 summarize the available raw and treated microbiological data for the Belleville Water Treatment Plant. The data show that the microbiological quality of the water leaving the plant is good.

Data for fecal coliforms in treated water and fecal streptococcus in raw and treated water were not available. Fecal coliforms, as well as total coliforms, were found in the raw water at levels in excess of guidelines, indicating that disinfection is necessary.

In our opinion, the chlorine feed system and operations policy for disinfection of the water are adequate.

F.3 Chlorinated By-Products

TRIHALOMETHANES

Trihalomethanes (THM's) are the most widely occurring organics found in drinking water, and they also appear at the highest concentrations. The principal source of THM's in drinking water is the chemical interaction of chlorine added for disinfection, with humic and fulvic substances that occur naturally in the raw water. There is some evidence that THM's are carcinogenic. The Ontario Drinking Water Objectives for THM's is 350 µg/L.

Based on the limited data available on THM's (see Table F.1) for the Belleville Water Treatment Plant, the levels of THM's found in treated water are under the Ontario Drinking Water Objectives of 350 µg/L (0.35 mg/L). Total THM values were determined by the direct aqueous injection method, which, for the treated water, ranged from 107 to 213 µg/L, with an average value of 170 µg/L.

A potential approach to lowering THM levels could be to reduce pre-chlorine dosages by about 1 mg/L and post-chlorinate using a 1 mg/L dosage. Essentially, this results in a delay of application of 1 mg/L of chlorine. Before this is adopted, it would have to be confirmed by testing.

TOTAL ORGANIC HALIDES

The terms of reference require that consideration be given to the reduction of chlorinated by-products in the treated water. There was no complete set of information on the total concentrations of all organohalogen compounds.

It is our opinion that a broader measurement of chlorinated by-products should be considered and possibly a surrogate measurement should be utilized. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

TABLE F.1

Trihalomethane Data for Belleville WTP

		1984			1985			1986		
		R	T	D*	R	T	D*	R	T	D*
JAN	Chloroform				ND	86	111	ND	102	140
FEB	($CHCl_3$)									
MAR					ND	78	98			
APR					ND	101	121	ND	204	232
MAY		ND	132	152	ND	147	166	ND	176	187
JUN					ND	159	163	ND	167	147
JUL					ND	166	154			
AUG								ND	190	v
SEP		ND	112	116	ND	147	135			
OCT		ND	128	122	ND	132	133	ND	111	129
NOV		ND	89	104	ND	113	130			
DEC		ND	81	107	ND	97	149			
JAN	Bromodichloro-				ND	6	11	ND	5	9
FEB	methane									
MAR	($CHBrCl_2$)				ND	5	13			
APR					ND	6	11	ND	9	11
MAY		ND	7	8	ND	8	12	ND	20	15
JUN					ND	8	12	ND	14	15
JUL					ND	13	15			
AUG								ND	13	v
SEP		ND	12	14	ND	13	14			
OCT		ND	11	14	ND	10	15	ND	10	12
NOV		ND	7	12	ND	8	14			
DEC		ND	7	15	ND	4	9			
JAN	Chlorodibromo-				ND	ND	ND	ND	ND	ND
FEB	methane									
MAR	($CHBr_2Cl$)				ND	ND	ND			
APR					ND	ND	ND	ND	ND	ND
MAY		ND	ND	ND	ND	ND	ND	ND	ND	ND
JUN					ND	ND	ND	ND	ND	ND
JUL					ND	ND	ND			
AUG								ND	ND	v
SEP		ND	ND	ND	ND	ND	ND			
OCT		ND	ND	ND	ND	ND	ND	ND	ND	ND
NOV		ND	ND	ND	ND	ND	ND			
DEC		ND	ND	ND	ND	ND	ND			
JAN	Bromoform									
FEB	($CHBr_3$)									
MAR										
APR										
MAY										
JUN										
JUL										
AUG										
SEP										
OCT										
NOV										
DEC										

TABLE F.1 (cont'd.)

		1984			1985			1986		
		R	T	D*	R	T	D*	R	T	D*
JAN	Total THM's				ND	92	122	ND	107	149
FEB										
MAR		ND	139	160	ND	83	111			
APR					ND	107	132	ND	213	243
MAY					ND	155	178	ND	196	202
JUN					ND	167	175	ND	181	162
JUL					ND	179	169			
AUG								ND	203	v
SEP		ND	124	130	ND	160	149			
OCT		ND	139	136	ND	142	148	ND	121	141
NOV		ND	96	116	ND	121	144			
DEC		ND	88	122	ND	101	158			
AVG.		ND	117	133	ND	131	149	ND	170	179
RNG.			88-124	116-160		83-179	111-178		107-213	141-243

R = Raw water
T = Treated water
D = Distributed water

* Samples were not preserved with sodium thiosulphate. Concentrations at consumers tap will be lower.
v Broken in transit.

SECTION G

SHORT AND LONG-TERM MODIFICATIONS

SECTION G
SHORT AND LONG-TERM MODIFICATIONS

G.1 Description

(a) General

Since March 1987, Belleville has been participating in the Drinking Water Surveillance Program. The Ministry recommends that Belleville continue their involvement in this program.

This section includes feasible short and long-term process modifications required to approach optimum disinfection and particulate removal. It is important to note that the Belleville U.C. is in the process of identifying areas of concern and planning the appropriate action.

The November 1986 "Belleville Water Purification Planning Study" by Gore & Storrie Limited, identified the following areas of concern:

- Equipment in serious need of replacement, including:
  - most valves throughout the plant
  - most valve operators
  - travelling water screen
  - chlorinators
  - instrumentation
  - control systems
  - heating system
- Insufficient capacity in microstrainers - bypassed when rates exceed 22.7 ML/d
- Crowded chemical storage facilities
- Deterioration of concrete in various areas
- Inadequate laboratory/office/staff facilities
- High noise levels
- Corrosion of equipment and piping
- Deterioration in the buildings

Most of the concerns are a result of deterioration due to age and the result of postponing capital improvements.

(a) General (cont'd)

The following short and long-term recommendations were provided, discussed, reviewed, and agreed upon at the plant site meeting.

We have assigned costs for each of the recommended works. Clearly, these costs may be reduced if the Utility Commission carries out the work.

G.2 Raw Water Flow Metering

The raw water flow metering is reported to be fairly accurate, and is calibrated each month by the plant staff.

It is recommended that a detailed service evaluation be conducted to establish the life of this unit.

This item could be conducted as soon as possible. The cost for this is minimal.

G.3 Streaming Current Monitor (SCM)

Accurate and timely adjustments to the coagulant feed rates are vital to achieve optimum particulate removal. The present time lag between the alum feed adjustment and the results at the filter inlet is several hours. The purpose of the SCM is to permit a response to changing raw water conditions in a few minutes.

It is recommended that a SCM be installed on a trial basis, and, if the merits of a SCM are demonstrated, that a SCM be purchased and installed permanently.

The installation of the SCM should be within the next year. The cost is $10,000 to $20,000, depending on the associated equipment.

G.4 Coagulant Aids

Laboratory testing by Gore & Storrie Limited on the Belleville raw water demonstrated that the use of a polyelectrolyte was required to ensure the lowest possible filtered water turbidity.

It is recommended that a laboratory study be carried out to pre-screen the various polyelectrolytes available for use as coagulant aids. Plant staff have investigated the use of activated silica, and have found it to be quite successful.

A plant-scale pilot program should be conducted for various seasons of the year using the preferred polyelectrolytes as coagulant aids.

The laboratory study can be conducted immediately. The plant-scale pilot program should be delayed until the SCM is installed.

The cost for equipment to carry out this test work is $30,000, and the cost of the chemical is $5,000 to $10,000 for a one-year test.

G.5 Flow Pattern in Flocculation Tanks

The flocculation tanks at the Belleville Water Treatment Plant are over and under hydraulic tanks. The water enters the bottom of the first cell, the top of the second cell, the bottom of the third cell, etc. Test work at other facilities has shown improved performance when all cells have bottom entries.

It is recommended that a trial evaluation be conducted by converting one group of flocculation cells to "bottom" entry. Should this testing be successful, it is recommended that all cells be converted to "bottom" entry. This conversion can be done by using corner baffles.

The trial conversion should be conducted at the same time as the repair work in the flocculation tanks. The cost to modify one set of cells is approximately $15,000.

G.6 Isolation of Floc Tanks

Since the level of mixing in the flocculation tanks is proportional to the flow rate, there may be some benefit obtained by shutting off groups of flocculation tanks. The isolation of flocculation tanks also isolates the associated settling tanks. There is concern over freezing occurring in the isolated tanks. Throttling is an alternative which would maintain low flows through the tanks and solve the problem of icing.

It is recommended that the operation of the flocculation tanks at various flow rates be compared.

This plant-scale work should be carried out during periods when the overall plant flows are lower. The cost of this recommendation is minimal.

G.7 Filter Backwashing

The normal backwashing procedure at the Belleville plant consists of closing the influent and effluent valves and operating the surface agitators for 5 to 6 minutes. The water from the washwater tank then backwashes the filter for 5 to 7 minutes.

The immediate rehabilitation works for the plant includes some modifications to the filters. If not already part of the planned works, it is recommended that the backwash procedure be examined and optimized.

The cost of this work is approximately $5,000 to $10,000.

G.8 Filter Media Characteristics

The characteristics of filter media can change with time. Media can be lost during backwashing and, in some instances, media can escape through support systems and end up in the clearwell. The anthracite media actually breaks up by mechanical abrasion over a period of time.

G.8 Filter Media Characteristics (cont'd)

It is recommended that sieve analysis and grain size characterization be carried out immediately on each filter, and this should be repeated once every five years, and the results recorded. The distance from the filter walkway to the top of the media for each filter should be measured and recorded once every year. This measurement should be carried out at four locations in each filter immediately after placing the filter back on line following a backwash.

These records become an early warning of media problems.

G.9 Treated Water Metering

There are three treated water flow meters.

It is recommended that the transmitters and recorders for the two smaller meters be replaced with new instruments having solid state electronics.

This recommendation should be implemented immediately. The cost is approximately $15,000 for the instruments, and $2,000 for installation. This has been contemplated as part of the immediate rehabilitation works for the plant.

G.10 Trihalomethane Formation

The total trihalomethane (TTHM) values during the 1984 to 1986 period ranged from 107 to 213 µg/L, with an average value of 170 µg/L. Although these values are below the guideline of 350 µg/L, the TTHM level should be reduced if possible. In theory, the level of THMs could be lowered by delaying chlorination to after settling; however, due to the high dissolved organics in the Belleville raw water, this approach may have limited success.

It is recommended that a study be conducted to evaluate the possible methods of THM reduction. The feasibility if implementing THM reduction methods, such as delaying or partially delaying chlorination within the process until some of the THM precursors are removed, should be assessed.

This study could be started immediately and would cost $35,000 to $50,000.

G.11 Chlorinated By-Products

It is Gore & Storrie's opinion that a broader measurement of chlorinated by-products should be considered. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum total of all the organic halogen compounds.

It is recommended that the Province of Ontario develop a surrogate for measurement of chlorinated by-products.

G.12 Fluoride Application

From the fluoride dosages and residuals recorded in Tables 4.1 and 4.2, Appendix A, it appears that there may be some fluoride demand.

It is recommended that controlled testing be conducted to determine if the present method of adding alum and fluoride together is responsible for the fluoride consumption. If the alum is consuming fluoride, consideration should be given to moving the fluoride injection point in the proposed facilities.

The testing can be conducted immediately, and if required, a new fluoride injection point can be incorporated into the new facilities. The cost of the testing would be $5,000 to $10,000.

G.13 Record of Information

The nature, frequency, and arrangement of information recorded about plant operations is vital to the operation and management of a water treatment plant.

A particularly useful set of operating data is the Turbidity Profile through the plant. These records indicate the effects of changing conditions on specific operations through the process. It is recommended that raw, settled, and filtered water turbidities be recorded at least once every four hours.

G.13 Record of Information (cont'd)

The Plant's record of information should also include the following:

- Process and piping diagram (PAPD)
- Filter media characteristics
- Drawings
- Any data to be used in the future for operation of the Plant or design purposes.

APPENDIX A
TABLES

WPOS - BELLEVILLE WTP

		1986			1985			1984			1983		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	RT	26.0	20.0	23.5	25.9	20.7	22.7	27.3	20.9	24.5	27.8	20.5	24.8
FEB	RT	25.4	20.5	23.5	25.9	20.0	22.9	28.1	22.8	26.0	28.9	21.8	26.1
MAR	RT	26.7	18.4	23.3	25.3	20.1	22.5	28.0	21.9	25.0	28.4	20.9	25.1
APR	RT	28.4	20.3	24.2	27.3	20.2	23.1	23.9	22.1	23.9	27.2	20.4	24.5
MAY	RT	35.4	21.6	26.7	33.5	21.4	25.5	27.8	20.4	26.7	28.5	20.7	25.1
JUN	RT	32.7	20.7	27.1	32.0	20.6	25.6	28.2	23.2	30.4	42.5	20.5	30.7
JUL	RT	(44.0)	22.0	32.4	38.9	24.2	31.9	(36.3)	22.4	29.5	(43.1)	24.8	28.2
AUG	RT	31.8	22.9	27.4	(40.6)	20.2	31.1	(36.3)	23.1	28.5	32.6	22.1	28.2
SEP	RT	30.6	21.7	26.8	31.0	22.1	25.9	29.9	21.3	26.6	29.5	21.1	26.2
OCT	RT	27.9	20.9	25.3	29.7	21.0	24.3	27.8	21.3	25.3	28.6	19.8	24.8
NOV	RT	26.5	20.7	23.8	28.0	20.6	23.8	27.0	20.3	24.0	26.7	19.0	23 6
DEC	RT	26.3	19.5	23.8	28.2	19.9	22.8	25.8	18.6	22.7	25.6	18.5	23.0

NOTE: Brackets indicate maximum day for the year. Raw water flows are measured with a 610 mm venturi meter. Flow measurement is discussed in Section B of this report.

TABLE 1.1: PER CAPITAL CONSUMPTION (L/DAY/CAPITA)

WPOS - BELLEVILLE WTP

	1986	1985	1984	1983
POPULATION (1)	36,720	36,720	35,351	35,351
MAX	1198	1106	1027	1219
MIN	501	542	526	523
AVE	699	686	738	731
MD/AD	1.71	1.61	1.39	1.67

NOTE: Based on raw water flows.

MD/AD = Maximum Day / Average Day.
(1) = Data supplied by Belleville Utilities Commission

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

WPOS - BELLEVILLE WTP

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	Turbidity (FTU)		R	6.2	0.70	1.9	2.1	1.2	1.5	1.3	0.80	1.0	2.6	0.82	1.4
			T	0.93	0.35	0.45	0.52	0.28	0.45	0.44	0.30	0.40	0.42	0.34	0.60
	Alum	(mg/L)		32.8	25.7	30.6	37.1	27.1	32.0	31.4	24.2	27.3	32.8	27.1	28.7
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R	7.80	7.60	7.70	8.0	7.7	7.79	7.95	7.60	7.7	7.75	7.5	7.64
			T	7.05	6.85	6.97	7.0	6.7	6.89	7.10	6.90	6.96	7.3	6.85	6.74
	Temperature	(^{o}C)		1.5	1.0	1.23	1.5	1.0	1.42	2.0	1.5	1.7	2.0	1.0	1.18
FEB	Turbidity (FTU)		R	3.4	0.34	1.0	2.7	0.70	1.5	7.7	0.81	2.1	21.0	0.34	4.2
			T	0.93	0.30	0.45	0.59	0.31	0.40	0.54	0.21	0.31	0.61	0.30	0.41
	Alum	(mg/L)		35.6	21.8	29.6	37.1	26.4	30.3	35.6	25.7	29.6	42.8	27.1	32.0
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R									0.031			
			T									0.170			
	pH		R	7.9	7.65	7.76	7.9	7.7	7.77	7.85	7.60	7.67	7.7	7.35	7.54
			T	7.0	6.8	6.95	7.0	6.85	6.94	7.0	6.85	6.91	6.8	6.5	6.61
	Temperature	(^{o}C)		1.5	1.0	1.27	1.5	1.0	1.03	2.0	1.5	1.6	2.5	1.5	1.73
MAR	Turbidity (FTU)		R	41.0	0.50	4.1	27.0	1.0	3.3	2.40	0.90	1.3	2.4	1.2	1.7
			T	0.90	0.32	0.40	0.49	0.28	0.43	0.36	0.24	0.30	0.48	0.31	0.45
	Alum	(mg/L)		28.5	24.2	26.4	45.2	28.5	33.9	32.8	27.1	29.3	31.4	28.5	29.5
	PACl	(mg/L)	(1)	23.6	7.2	11.5									
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R										0.130	0.130	0.130
			T										0.240	0.240	0.240
	pH		R	7.70	7.60	7.61	7.95	7.70	7.79	7.8	7.5	7.69	8.3	7.65	8.02
			T	7.15	6.80	7.04	7.00	6.80	6.92	7.0	8.75	6.84	7.1	6.65	6.88
	Temperature	(^{o}C)		2.5	1.0	1.46	4.0	1.0	1.5	1.5	1.0	1.1	5.0	2.0	3.2

(1) Poly Aluminium Chloride used as prime coagulant March 5 to March 31, 1986.

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
APR	Turbidity (FTU)		R	3.1	1.5	2.2	14.0	1.1	2.5	18.0	1.4	3.2	2.0	1.2	1.4
			T	0.53	0.17	0.36	0.40	0.27	0.35	0.40	0.24	0.32	0.38	0.24	0.30
	Alum	(mg/L)	(2)				39.9	25.7	32.5	47.0	27.1	32.5	31.4	29.9	30.2
	PAC1	(mg/L)		11.6	7.04	9.4									
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R						0.140						
			T						0.140						
	pH		R	8.2	7.8	8.0	8.2	7.8	8.0	8.05	7.7	7.9	8.3	8.0	8.2
			T	7.3	7.1	7.2	7.0	6.8	6.9	7.0	6.8	6.9	7.0	6.8	7.0
	Temperature	(^{o}C)		14.0	5.0	9.2	13.0	3.0	6.9	11.5	2.0	6.9	9.0	2.5	6.4
MAY	Turbidity (FTU)		R	4.5	1.4	2.3	2.4	1.1	1.5	16.0	2.0	3.7	3.1	1.2	2.0
			T	0.50	0.20	0.35	0.46	0.28	0.36	0.75	0.24	0.40	0.40	0.26	0.32
	Alum	(mg/L)		33.4	25.9	18.9	34.2	24.2	31.0	42.8	28.5	31.7	32.8	29.9	30.8
	PAC1	(mg/L)	(3)	7.8	3.0	5.9									
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R	8.4	7.8	8.2	8.4	8.0	8.2	8.45	7.9	8.2	8.4	7.9	8.0
			T	7.4	6.8	7.0	7.05	6.8	7.0	7.1	6.8	7.0	7.15	6.85	7.0
	Temperature	(^{o}C)		21.0	13.0	16.2	18.5	13.5	15.9	17.0	10.5	13.3	15.5	10.0	13.4
JUN	Turbidity (FTU)		R	3.2	1.6	2.2	4.8	1.8	3.4	5.8	2.0	3.5	3.2	1.5	2.0
			T	0.42	0.26	0.31	0.62	0.30	0.45	0.85	0.39	0.60	0.63	0.34	0.47
	Alum	(mg/L)		31.4	26.7	29.3	39.9	27.1	31.6	33.8	28.5	30.4	34.2	28.5	30.6
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R	8.2	7.7	7.8	8.2	7.9	8.0	8.4	8.1	8.3	8.15	7.65	8.0
			T	6.9	6.7	6.8	7.0	6.8	6.9	7.0	6.9	6.95	7.1	6.9	7.0
	Temperature	(^{o}C)		22.0	19.0	20.2	20.0	17.5	18.8	22.5	15.0	20.6	24.0	16.0	19.6

(2) Poly Aluminium Chloride used as prime coagulant for April 1986.
(3) Poly Aluminium Chloride used as prime coagulant May 1-11, 1986.

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	Turbidity (FTU)		R	3.7	1.9	2.6	4.4	2.5	3.8	9.4	3.0	6.0	5.8	2.4	4.3
			T	0.42	0.24	0.32	0.78	0.36	0.49	1.00	0.50	0.75	0.62	0.41	0.53
	Alum	(mg/L)		33.9	24.9	28.0	32.8	29.9	31.4	34.2	25.7	29.7	32.8	30.1	31.5
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R	8.1	7.6	7.8	8.6	7.9	8.4	8.6	8.2	8.4	8.2	7.8	8.0
			T	6.9	6.65	6.8	7.0	6.9	7.0	7.2	6.9	7.0	7.1	6.9	7.0
	Temperature	(^{o}C)		25.0	21.0	23.2	24.0	20.0	22.2	24.5	22.0	23.1	25.0	23.0	24.1
AUG	Turbidity (FTU)		R	5.6	2.8	3.7	5.6	3.2	4.1	14.0	6.2	7.9	8.5	2.7	4.5
			T	0.43	0.28	0.31	0.77	0.46	0.59	0.78	0.43	0.60	0.70	0.38	0.50
	Alum	(mg/L)		33.4	28.1	30.7	34.2	28.5	30.6	57.0	31.4	45.4	33.5	29.9	31.8
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												0.150
			T												0.150
	pH		R	8.3	7.7	8.1	8.6	8.1	8.4	8.5	8.0	8.3	8.2	7.8	8.1
			T	7.0	6.7	6.8	7.0	6.9	7.0	7.0	6.7	6.8	7.1	6.9	7.0
	Temperature	(^{o}C)		26.0	19.0	23.2	24.0	21.0	23.0	26.0	23.0	24.1	25.5	22.0	23.8
SEP	Turbidity (FTU)		R	5.0	2.0	2.2	5.2	3.7	4.3	7.4	4.2	5.9	5.8	3.3	4.5
			T	0.32	0.20	0.26	0.60	0.34	0.40	0.70	0.41	0.50	0.52	0.36	0.40
	Alum	(mg/L)		33.6	24.7	28.1	31.4	28.5	30.0	51.3	42.8	45.5	34.2	28.5	31.2
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R	8.1	7.6	7.8	8.4	7.9	8.1	8.4	8.0	8.3	8.4	8.1	8.2
			T	7.0	6.7	6.9	7.0	6.8	7.0	7.0	6.7	6.8	7.1	7.0	7.1
	Temperature	(^{o}C)		20.5	16.0	18.1	21.0	18.0	19.1	22.5	16.5	18.9	25.0	17.0	20.6

TABLE 2.0 (cont'd.)

				1986			1985			1984			1983		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
OCT	Turbidity (FTU)		R	3.6	1.5	2.2	5.4	2.1	3.5	5.7	3.2	4.4	21.0	2.8	4.4
			T	0.36	0.18	0.23	0.44	0.27	0.34	0.60	0.35	0.40	0.42	0.32	0.40
	Alum	(mg/L)		35.8	28.5	30.3	41.3	24.2	33.5	42.8	35.6	39.1	42.8	28.5	30.8
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R	8.0	7.7	7.9	8.2	7.8	8.0	8.5	8.1	8.3	8.4	8.0	8.2
			T	7.0	6.8	6.9	7.0	6.8	6.9	7.1	6.8	6.9	7.2	7.0	7.1
	Temperature	(^{o}C)		17.0	11.0	12.9	18.5	11.0	13.7	16.0	13.0	13.9	18.0	8.5	13.2
NOV	Turbidity (FTU)		R	3.3	1.0	1.8	15.0	1.0	2.6	4.4	2.0	2.7	4.2	2.0	2.6
			T				0.58	0.29	0.40	0.52	0.27	0.40	0.58	0.30	0.40
	Alum	(mg/L)		39.7	28.0	31.3	37.1	28.5	33.5	35.6	25.7	32.0	31.4	27.1	28.7
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R						0.040			0.094			0.083
			T						0.170			0.260			0.450
	pH		R				8.0	7.9	8.0	8.4	7.9	8.1	8.3	7.8	7.9
			T				7.0	6.8	7.0	7.2	6.9	7.0	7.2	6.9	7.1
	Temperature	(^{o}C)					10.0	2.0	5.8	12.0	3.0	6.5	9.0	3.0	5.7
DEC	Turbidity (FTU)		R				15.0	0.8	2.4	7.0	1.6	3.7	3.9	1.1	1.9
			T				0.64	0.30	0.40	0.48	0.34	0.40	0.53	0.31	0.35
	Alum	(mg/L)					41.3	25.2	36.1	35.3	27.1	30.9	28.5	22.8	27.0
	Filter Aid	(mg/L)													
	Metal Res. (Al)	(mg/L)	R												
			T												
	pH		R				7.9	7.6	7.8	8.2	7.9	8.0	8.0	7.7	7.8
			T				7.0	6.8	6.9	7.0	6.8	6.0	7.1	7.0	7.0
	Temperature	(^{o}C)					2.0	1.0	1.4	4.0	1.0	1.8	3.0	1.0	1.6

NOTE: Turbidity, pH and temperature are done daily in the Belleville WTP lab. Coagulant dosages are verified by day tank level readings.

TABLE 2.1: PARTICULATE REMOVAL PROFILE (AUG./1985)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter (1)	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	3.6		0.54	0.61	31.4					8.25	6.95	22.5
2	4.3		0.57	0.54	31.4					8.30	7.0	22.5
3	4.0		0.60	0.58	31.4					8.3	7.0	22.5
4	3.8		0.63	0.56	31.4					8.3	7.0	22.5
5	4.0		0.57	0.53	31.4					8.05	6.95	23.0
6	3.3		0.57	0.59	31.4					8.15	6.95	23.5
7	4.0		0.59	0.62	31.4					8.3	7.0	23.5
8	4.6		0.63	0.56	32.8					8.35	6.95	23.5
9	4.1		0.63	0.60	31.4					8.4	6.95	23.5
10	3.2		0.62	0.62	31.4					8.1	6.9	23.5
11	3.6		0.60	0.63	32.8					8.1	6.9	24.0
12	3.3		0.58	0.77	29.9					8.5	6.9	23.5
13	4.2		0.55	0.56	31.4					8.5	6.95	24.0
14	3.4		0.54	0.56	32.8					8.35	6.95	24.0
15	3.5		0.57	0.52	34.2					8.4	7.0	24.0

(1) All filtered turbidities are measured with a Lisle-Metrix DRT 285 J497B continuous turbidity meter. They are recorded on the filter wash records each time a filter is washed. The other turbidities are measured with the HF Instruments DRT 100 and recorded on daily log sheets.

TABLE 2.1 (AUG. 1985) (cont'd)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	3.8		0.50	0.46	32.8					8.25	6.45	24.0
17	3.7		0.57	0.51	28.5					8.3	7.0	24.0
18	3.5		0.59	0.57	29.9					8.35	6.95	23.5
19	4.1		0.62	0.62	29.9					8.4	7.0	24.0
20	3.8		0.58	0.56	29.9					8.2	6.95	23.5
21	4.2		0.61	0.68	29.9					8.3	6.95	23.0
22	4.7		0.57	0.59	28.5					8.6	7.0	23.0
23	5.6		0.58	0.68	28.5					8.4	6.95	22.5
24	5.0		0.60	0.65	28.5					8.4	7.0	22.5
25	5.4		0.58	0.63	29.9					8.5	7.0	22.0
26	4.7		0.58	0.64	29.9					8.3	6.95	22.0
27	4.4		0.53	0.50	29.9					8.3	7.0	22.0
28	4.7		0.52	0.51	29.9					8.4	7.0	22.0
29	4.3		0.54	0.55	29.9					8.4	7.0	21.5
30	4.6		0.50	0.63	29.9					8.4	7.0	21.0
31												

NOTE: Data is illegible for the 31st.

TABLE 2.2: PARTICULATE REMOVAL PROFILE (SEPT./1985)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	4.4		0.55	0.58	29.9					8.4	7.0	19.0
2	4.8		0.54	0.52	29.9					8.4	6.95	19.0
3	5.0		0.53	0.58	29.9					8.35	6.9	19.0
4	4.6		0.53	0.56	29.9					8.4	7.0	20.0
5	4.0		0.55	0.50	29.9					8.3	6.95	20.0
6	4.9		0.58	0.58	28.5					8.1	6.9	20.0
7	3.9		0.56	0.56	29.9					8.0	6.85	20.5
8	3.1		0.55	0.56	29.9					8.0	6.85	21.0
9	3.8		0.51	0.60	29.9					7.9	6.8	20.5
10	4.3		0.52	0.50	29.9					7.85	6.85	21.0
11	4.4		0.50	0.45	29.9					7.85	6.9	20.5
12	4.5		0.45	0.44	29.9					7.95	6.95	19.5
13	4.2		0.50	0.37	29.9					8.0	7.0	19.0
14	5.2		0.50	0.41	29.9					7.95	6.9	18.0
15	4.8		0.51	0.42	29.9					7.95	6.9	18.0

TABLE 2.2 (SEPT. 1985) (cont'd)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	5.0		0.55	0.45	29.9					8.05	7.0	18.0
17	4.4		0.54	0.44	29.9					7.9	6.90	18.0
18	4.8		0.54	0.44	29.9					8.0	7.0	18.0
19	4.2		0.50	0.42	29.9					7.8	6.9	18.5
20	3.7		0.47	0.44	29.9					8.0	6.95	19.0
21	4.0		0.50	0.44	29.9					8.0	7.0	19.0
22	3.9		0.50	0.42	29.9					8.0	7.0	18.5
23	4.0		0.47	0.40	29.9					8.1	6.95	19.0
24	4.4		0.48	0.38	29.9					8.2	6.9	19.5
25	4.2		0.45	0.36	29.9					8.1	6.9	19.0
26	4.6		0.45	0.34	31.4					8.15	7.0	19.0
27	4.3		0.50	0.40	31.4					8.2	6.9	19.0
28	4.4		0.45	0.38	31.4					8.1	7.0	18.0
29	4.4		0.45	0.36	31.4					8.0	7.0	18.0
30	3.7		0.45	0.38	31.4					8.15	7.0	18.0

TABLE 2.3: PARTICULATE REMOVAL PROFILE (JULY 1984)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	5.2			0.50	30.9					8.3	6.9	22.0
2	3.0			0.50	31.8					8.3	6.9	22.0
3	3.6			0.58	28.5					8.2	6.95	22.5
4	4.3			0.62	30.8					8.35	7.0	23.0
5	4.0			0.66	29.9					8.3	7.0	23.5
6	4.3			0.63	31.4					8.35	6.9	23.5
7	4.2			0.62	31.4					8.3	7.0	23.5
8	4.4			0.62	32.8					8.35	7.0	22.0
9	5.2			0.62	28.5					8.35	7.0	22.0
10	5.8			0.66	31.4					8.5	7.0	22.0
11	5.2			0.65	28.5					8.4	7.0	22.0
12	5.6			0.67	34.2					8.35	7.0	22.0
13	6.2			0.68	25.7					8.35	7.05	22.5
14	5.2			0.65	32.8					8.35	7.05	22.5
15	6.0			0.78	27.1					8.4	7.1	23.5

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{O}C)
16	6.2			0.70	31.4					8.4	7.05	23.5
17	6.2			0.78	27.1					8.4	7.1	22.5
18	7.0			0.74	29.9					8.4	7.15	23.5
19	6.6			0.80	28.5					8.5	7.15	23.0
20	5.0			0.76	29.9					8.4	7.15	23.0
21	5.6			0.84	27.1					8.4	7.1	23.0
22	6.0			0.79	29.9					8.55	7.15	23.0
23	8.4			0.80	27.1					8.4	7.0	24.5
24	8.4			0.82	29.9					8.4	7.0	24.0
25	8.6			0.87	25.7					8.4	7.05	24.0
26	8.6			0.78	29.9					8.5	7.0	24.0
27	9.4			1.00	25.7					8.5	7.1	24.0
28	8.8			0.98	34.2					8.5	7.0	24.0
29	8.3			0.85	25.7					8.45	7.0	24.0
30	6.8			0.70	29.9					8.3	6.95	23.5

Note: No legible data for the 31st.

TABLE 2.4: PARTICULATE REMOVAL PROFILE (AUG. 1984)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	14.0			0.74	31.4					8.45	6.95	23.5
2	9.0			0.69	57.0					8.4	6.9	23.5
3	7.7			0.56	45.6					8.4	6.95	24.0
4	6.8			0.50	51.3					8.4	6.9	24.0
5	7.2			0.46	51.3					8.4	6.9	23.5
6	5.6			0.51	51.3					8.05	6.95	24.0
7	7.0			0.71	47.0					8.1	6.9	24.5
8	7.0			0.76	41.3					8.3	6.8	24.5
9	7.3			0.74	45.6					8.4	6.85	25.5
10	9.5			0.58	42.8					8.4	6.8	26.0
11	8.0			0.65	44.2					8.3	6.8	26.0
12	8.2			0.72	52.7					8.25	6.8	25.5
13	8.0			0.77	45.6					8.15	6.7	25.5
14	6.2			0.50	45.6					8.0	6.8	25.5
15	7.2			0.57	45.6					8.2	6.75	25.5

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	8.5			0.56	42.6					8.3	6.75	25.5
17	8.2			0.54	43.3					8.2	6.75	25.0
18	8.0			0.60	43.8					8.3	6.80	24.5
19	8.1			0.55	42.6					8.3	6.80	24.0
20	8.2			0.57	42.6					8.2	6.85	23.5
21	8.2			0.51	42.5					8.3	6.80	23.5
22	8.3			0.75	41.6					8.5	6.95	23.5
23	8.5			0.68	42.8					8.45	6.85	23.5
24	8.1			0.78	42.8					8.35	6.85	22.5
25	8.0			0.60	45.6					8.2	6.80	22.0
26	6.2			0.46	44.2					8.05	6.70	22.0
27	7.8			0.43	44.2					8.45	6.70	23.0
28	6.5			0.52	44.2					8.0	6.75	23.5
29	6.7			0.60	44.2					8.1	6.75	23.0
30	8.6			0.43	45.6					8.3	6.70	23.0

Note: No legible data for the 31st.

TABLE 2.5: PARTICULATE REMOVAL PROFILE (SEPT. 1984)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	6.8			0.64	47.0					8.35	6.7	22.5
2	7.0			0.66	45.6					8.3	6.75	22.5
3	7.0			0.53	45.6					8.0	6.75	22.0
4	7.2			0.60	44.2					8.1	6.75	20.0
5	6.8			0.54	44.2					8.2	6.8	20.0
6	7.0			0.49	44.2					8.1	6.95	19.5
7	7.4			0.43	45.6					8.15	7.0	19.0
8	7.5			0.47	45.6					8.2	6.9	19.0
9	6.5			0.57	45.6					8.35	6.85	19.5
10	6.7			0.50	42.8					8.3	6.85	19.0
11	6.2			0.53	44.2					8.2	6.85	19.5
12	6.0			0.50	42.8					8.3	6.8	19.0
13	5.5			0.54	44.2					8.35	6.8	19.5
14	7.0			0.55	45.6					8.3	6.9	19.0
15	6.8			0.50	47.0					8.3	6.9	18.5

TABLE 2.5 (SEPT. 1984) (cont'd)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	5.6			0.44	45.6					8.25	7.0	18.0
17	5.3			0.41	44.2					8.5	6.95	18.0
18	5.1			0.43	42.8					8.25	6.85	17.5
19	5.5			0.45	45.6					8.2	6.8	18.0
20	5.2			0.70	44.2					8.3	6.9	18.0
21	5.6			0.55	45.6					8.3	7.0	18.0
22	5.8			0.50	48.5					8.4	7.0	18.0
23	5.2			0.50	45.6					8.4	6.9	18.0
24	5.6			0.47	48.5					8.4	6.9	18.5
25	5.3			0.48	44.2					8.25	6.85	19.0
26	5.8			0.52	42.8					8.3	6.95	18.0
27	4.4			0.42	50.0					8.4	7.0	17.5
28	4.8			0.46	51.3					8.3	7.0	17.0
29	4.6			0.46	48.5					8.4	7.0	16.5
30	4.2			0.42	42.8					8.3	7.0	16.5

TABLE 2.6: PARTICULATE REMOVAL PROFILE (MAR/1986)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT Alum/PACl	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	0.6			0.5	28.5					7.7	7.0	1.5
2	0.6			0.55	25.7					7.6	6.9	1.5
3	0.6			0.47	25.7					7.65	6.8	1.5
4	0.6			0.55	24.2					7.65	6.9	1
* 5	0.5			0.45	9.6*					7.6	7.0	1
6	0.52			0.42	9.4					7.6	7.1	1
7	0.52			0.44	9.0					7.7	7.15	1.5
8	0.5			0.35	8.5					7.65	7.1	1.5
9	0.5			0.45	8.4					7.7	7.1	1.5
10	0.55			0.48	7.2					7.7	7.0	2
11	0.58			0.40	9.28					7.6	7.1	1.5
12	0.58			0.51	8.03					7.6	7.15	1.5
13	0.62			0.51	12.1					7.7	7.15	1.5
14	1.60			0.42	12.3					7.7	7.1	1.5
15	1.56			0.40	12.8					7.7	7.1	1.5

Note: Use of STERNPAC as coagulant commenced March 5, 1986.

DATE	TURBIDITY (FTU)				COAGULANT (PACl)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	1.20			0.52	13.0					7.6	7.1	1.5
17	4.9			0.44	12.4					7.6	7.1	1.5
18	2.8			0.45	11.9					7.6	7.15	1.5
19	5.4			0.46	11.2					7.6	7.1	1.5
20	41.0			0.90	23.6					7.6	7.1	1.5
21	7.4			0.45	14.0					7.6	7.0	1.5
22	8.1			0.40	14.8					7.6	7.0	1
23	9.1			0.36	16.3					7.5	7.0	1.5
24	9.8			0.32	19.0					7.5	7.0	1
25	8.1			0.37	16.5					7.5	7.0	1.5
26	4.6			0.58	12.8					7.6	7.0	1.5
27	3.6			0.48	11.9					7.5	7.0	1.5
28	3.3			0.38	11.7					7.5	7.0	1.5
29	2.2			0.34	11.4					7.7	7.1	1.5
30	2.2			0.35	13.6					7.65	7.1	2.5

NOTE: No legible data for the 31st.

TABLE 2.7: PARTICULATE REMOVAL PROFILE (APR/1986)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (PACl)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	2.7			0.47	9.5					7.85	7.1	5
2	2.1			0.53	8.7					7.8	7.1	6
3	2.0			0.52	8.8					7.75	7.1	7
4	2.0			0.43	10.1					7.8	7.1	7.5
5	2.1			0.41	11.3					7.8	7.15	7.5
6	2.5			0.43	10.7					7.9	7.1	7
7	2.4			0.41	10.2					7.85	7.15	7
8	3.0			0.37	9.9					8.0	7.2	7.5
9	2.2			0.47	9.7					7.9	7.2	7
10	2.0			0.51	10.0					8.0	7.2	7
11	2.0			0.41	10.3					7.9	7.2	7
12	2.0			0.38	11.6					8.0	7.1	7
13	2.2			0.38	9.8					8.0	7.1	7
14	1.8			0.37	9.8					8.1	7.15	7.5
15	2.1			0.33	9.5					8.0	7.2	8

Note: Use of STERNPAC (PACl) as a coagulant continued through the month of April 1986.

TABLE 2.7 (APR. 1986) (cont'd)

DATE	TURBIDITY (FTU)				COAGULANT (PACl)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	1.8			0.35	10.6					8.05	7.3	7.5
17	1.5			0.27	10.5					8.15	7.2	7.5
18	1.8			0.28	9.0					8.1	7.2	8.5
19	1.7			0.21	9.4					8.0	7.3	9
20	1.7			0.17	9.5					8.1	7.3	11
21	1.8			0.17	10.4					8.15	7.2	11
22	1.9			0.18	9.1					8.05	7.2	10.5
23	2.6			0.23	7.9					8.1	7.2	10.5
24	2.0			0.32	8.1					8.15	7.25	10.5
25	2.3			0.34	8.0					8.15	7.3	11
26	2.9			0.32	7.6					8.2	7.3	11
27	3.1			0.33	7.9					8.2	7.3	12
28	2.1			0.40	7.2					8.15	7.25	14
29	2.0			0.38	8.0					8.0	7.1	13
30	3.0			0.37	7.0					8.15	7.15	14

TABLE 2.8: PARTICULATE REMOVAL PROFILE (MAY/1986)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT PACl/Alum	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	2.4			0.42	6.1					8.3	7.3	14.5
2	3.8			0.50	4.6					8.25	7.25	14
3	2.7			0.45	4.2					8.25	7.2	13.5
4	2.5			0.45	3.0					8.2	7.25	13
5	4.5			0.40	5.8					8.4	7.4	13
6	3.1			0.35	6.7					8.1	7.25	13
7	2.8			0.26	7.8					8.3	7.25	14
8	2.2			0.37	4.8					8.2	7.2	14
9	2.4			0.45	4.7					8.2	7.4	14
10	2.6			0.42	4.7					8.2	7.4	14
11	2.3			0.37	4.5					8.4	7.4	14
* 12	2.7			0.38	4.9					8.2	7.25	16
13	2.2			0.38	27.4					8.2	7.0	16
14	2.2			0.35	31.0					8.2	6.9	16
15	2.1			0.31	33.4					8.2	6.9	16.5

*Note: Coagulant switched back to Alum from PACl.
The experimental run with STERNPAC was terminated May 12, 1986.

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	1.8			0.27	32.4					8.2	6.9	17
17	1.9			0.20	35.7					8.2	6.8	17
18	1.4			0.29	32.7					8.2	6.8	17.5
19	1.6			0.25	34.4					8.2	6.9	18
20	2.4			0.24	34.0					8.1	6.8	17.5
21	2.2			0.30	32.8					7.9	6.75	17
22	2.0			0.24	28.5					7.9	6.85	17
23	2.4			0.30	29.3					7.8	6.85	17
24	2.3			0.32	27.8					8.0	6.9	17
25	2.9			0.37	29.3					8.0	6.9	17
26	2.8			0.44	25.9					7.85	6.9	17
27	1.9			0.39	26.8					8.2	6.95	20
28	1.6			0.46	26.0					8.3	6.95	20
29	1.6			0.35	27.4					8.3	6.95	21
30	1.5			0.47	26.2					8.2	6.95	21

NOTE: Data for the 31st is illegible.

TABLE 2.9: PARTICULATE REMOVAL PROFILE (MAR/1985)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	3.1			0.38	30.4					7.8	6.9	1
2	2.4			0.44	28.2					7.7	7.0	1
3	2.2			0.45	30.6					7.75	6.95	1
4	2.0			0.37	30.1					7.85	7.0	1
5	1.8			0.38	30.9					7.85	7.0	1
6	1.4			0.36	30.2					7.85	7.0	1
7	1.8			0.34	32.6					7.8	6.95	1
8	1.4			0.35	29.5					7.8	7.0	1
9	1.6			0.38	31.4					7.8	7.0	1
10	1.5			0.34	29.6					7.8	7.0	1
11	1.3			0.32	31.5					7.85	7.0	1
12	1.6			0.38	32.1					7.8	7.0	1
13	27.0			0.42	45.2					7.75	7.0	1
14	11.0			0.43	45.2					7.75	6.95	1
15	10.0			0.35	45.2					7.8	6.85	1

TABLE 2.9 (MAR. 1985) (cont'd)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{O}C)
16	8.0			0.38	45.2					7.8	6.9	1
17	5.0			0.36	44.9					7.8	6.9	1
18	2.6			0.41	41.9					7.8	6.9	1
19	2.0			0.38	37.1					7.9	6.95	1
20	1.8			0.40	37.3					7.9	6.9	1
21	1.5			0.40	38.5					7.85	6.9	1
22	1.1			0.28	34.2					7.8	6.9	1
23	1.1			0.34	31.4					7.7	6.8	2
24	1.2			0.42	30.8					7.7	6.8	2
25	1.3			0.45	29.9					7.8	6.9	2
26	1.2			0.41	28.5					7.7	6.8	2
27	1.6			0.49	28.5					7.7	6.8	3
28	1.2			0.34	28.5					7.7	6.8	3
29	1.0			0.31	28.5					7.75	6.9	4
30	1.2			0.32	29.9					7.85	7.0	4

NOTE: No legible data for the 31st.

TABLE 2.10: PARTICULATE REMOVAL PROFILE (APR/1985)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	1.4			0.32	29.9					7.95	7.0	3.5
2	2.4			0.40	29.9					7.95	7.0	3.5
3	2.4			0.36	29.9					7.95	7.0	3.5
4	1.8			0.32	29.9					7.9	7.0	3.5
5	2.0			0.32	29.9					7.95	7.0	3.5
6	14			0.36	35.6					8.0	6.95	3.5
7	6.1			0.34	39.9					7.9	6.9	3
8	4.2			0.27	35.6					7.8	7.0	3.5
9	3.4			0.30	37.1					7.9	7.0	3.5
10	2.8			0.31	34.2					7.9	6.9	4
11	2.9			0.30	35.6					8.0	7.0	4
12	2.5			0.32	35.6					7.95	7.0	4
13	2.6			0.30	35.6					7.9	7.0	5
14	2.4			0.28	34.2					7.95	7.0	5
15	2.0			0.31	31.4					8	7.0	6

TABLE 2.10 (APR. 1985) (cont'd)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	1.8			0.34	29.9					8.0	7.0	6
17	1.6			0.39	31.4					7.95	7.0	6.5
18	1.4			0.31	29.9					7.9	7.0	7
19	1.5			0.30	29.9					8.0	7.0	8
20	1.1			0.36	29.9					7.9	6.9	8
21	1.2			0.32	29.9					8.0	6.9	8.5
22	1.3			0.34	25.7					7.95	6.95	8.5
23	1.4			0.32	25.7					8.0	7.0	9
24	1.4			0.34	31.4					7.95	6.9	10
25	1.7			0.37	34.2					8.0	6.9	12
26	1.5			0.34	35.6					8.1	6.9	13
27	1.6			0.33	32.8					8.1	6.8	13
28	1.8			0.35	34.2					8.1	6.85	12.5
29	1.7			0.28	32.8					8.1	6.9	13
30	2.4			0.28	29.9					8.2	6.95	13

TABLE 2.11: PARTICULATE REMOVAL PROFILE (MAY/1985)

WPOS - BELLEVILLE WTP

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
1	2.0			0.32	34.2					8.15	6.8	13.5
2	2.0			0.32	31.4					8.15	6.85	13.5
3	2.0			0.28	31.4					8.2	6.85	13.5
4	2.4			0.30	31.4					8.15	6.8	13.5
5	2.3			0.32	31.4					8.25	6.8	14
6	2.2			0.28	31.4					8.15	6.9	14
7	1.8			0.30	29.9					8.15	6.95	14
8	2.2			0.46	29.9					8.1	6.95	14
9	1.4			0.39	29.9					8.05	6.95	14
10	1.7			0.32	29.9					8.15	7.0	14
11	1.5			0.32	29.9					8.1	7.0	14
12	1.2			0.30	29.9					8.05	7.0	15
13	1.1			0.29	29.9					8.15	7.05	16
14	1.2			0.36	27.1					8.3	7.05	16
15	1.2			0.46	27.1					8.35	7.05	16

TABLE 2.11 (MAY/1985) (cont'd)

DATE	TURBIDITY (FTU)				COAGULANT (ALUM)	COAG. AID	FILTER AID	METAL RES. (Al) (mg/L)		pH		TEMP.
	Raw	Set.	Filter	Treat.	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	(^{o}C)
16	1.3			0.38	32.8					8.40	7.0	16.5
17	1.1			0.41	29.9					8.3	7.05	17
18	1.4			0.40	31.4					8.3	6.95	17
19	1.2			0.43	31.4					8.3	6.9	17
20	1.5			0.37	31.4					8.3	6.95	16.5
21	1.4			0.35	28.5					8.2	7.0	17
22	1.2			0.36	28.5					8.25	7.0	17
23	1.2			0.36	27.1					8.2	7.05	17.5
24	1.1			0.41	24.2					8.25	7.05	18
25	1.2			0.40	25.7					8.2	7.05	18
26	1.6			0.40	28.5					8.1	6.9	18.5
27	1.3			0.41	29.9					8.15	6.9	18
28	1.6			0.38	28.5					8.0	6.9	18
29	1.6			0.42	29.9					8.0	6.8	18
30	1.4			0.35	29.9					8.0	6.9	18

NOTE: No legible data for the 31st.

TABLE 3.0: DISINFECTION SUMMARY

WPOS - BELLEVILLE WTP

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand												
	Cl_2 Dosage	3.6	3.1	3.3				2.5	2.3	2.3			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.0	1.1	1.4	0.8	0.5	0.7	1.5	1.0	1.3	0.9	0.6	0.7
	Resid. Cl_2 Comb.	0.5	0.1	0.4	0.4	0.1	0.2	0.6	0.2	0.3	0.3	0.2	0.2
	Resid. Cl_2 Total	2.4	1.3	1.7	1.1	0.8	0.9	2.0	1.4	1.6	1.2	0.8	0.9
FEB	Cl_2 Demand												
	Cl_2 Dosage	3.8	3.6	3.74				3.3	2.8	3.01			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.7	1.1	1.4	0.9	0.6	0.7	1.4	1.1	1.3	1.0	0.6	0.7
	Resid. Cl_2 Comb.	0.5	0.3	0.4	0.4	0.2	0.3	0.5	0.2	0.4	0.3	0.2	0.3
	Resid. Cl_2 Total	2.1	1.6	1.8	1.2	0.8	1.0	1.8	1.4	1.6	1.2	0.9	1.0
MAR	Cl_2 Demand												
	Cl_2 Dosage	4.2	3.8	3.9				3.6	2.9	3.1			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.6	1.1	1.4	1.2	0.6	0.7	1.8	1.1	1.4	1.0	0.5	0.8
	Resid. Cl_2 Comb.	0.6	0.3	0.5	0.3	0.1	0.2	0.6	0.3	0.4	0.4	0.1	0.2
	Resid. Cl_2 Total	2.1	1.4	1.8	1.4	0.7	1.0	2.1	1.4	1.8	1.2	0.6	1.0

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage	4.0	3.5	3.8				3.5	3.0	3.3			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.0	1.4	1.6	1.2	0.5	0.8	1.9	1.2	1.6	1.0	0.7	0.9
	Resid. Cl_2 Comb.	1.0	0.2	0.4	0.3	0.1	0.2	0.4	0.1	0.3	0.4	0.2	0.2
	Resid. Cl_2 Total	2.7	1.5	1.9	1.4	0.8	1.0	2.4	1.5	1.9	1.4	0.8	1.1
MAY	Cl_2 Demand												
	Cl_2 Dosage	4.8	3.8	4.3				4.2	3.5	3.9			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.3	1.3	1.9	1.2	0.5	0.8	2.6	1.2	1.8	0.9	0.4	0.7
	Resid. Cl_2 Comb.	0.6	0.2	0.4	0.4	0.2	0.3	0.6	0.2	0.3	0.3	0.1	0.2
	Resid. Cl_2 Total	2.7	1.7	2.2	1.5	0.8	1.1	3.0	1.5	2.1	1.2	0.7	1.0
JUN	Cl_2 Demand												
	Cl_2 Dosage	4.5	4.2	4.3				5.0	4.0	4.5			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.3	1.7	1.8	0.9	0.5	0.8	2.3	1.5	1.8	0.9	0.5	0.7
	Resid. Cl_2 Comb.	0.5	0.2	0.3	0.4	0.1	0.3	0.7	0.2	0.4	0.3	0.2	0.3
	Resid. Cl_2 Total	2.6	1.9	2.2	1.2	0.8	1.0	2.8	1.9	2.2	1.3	0.7	1.0

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand												
	Cl_2 Dosage	5.0	4.1	4.4				5.3	4.6	5.0			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.6	1.5	2.0	1.1	0.4	0.7	2.8	1.4	2.0	0.9	0.4	0.7
	Resid. Cl_2 Comb.	0.6	0.2	0.4	0.3	0.2	0.3	0.7	0.3	0.5	0.4	0.2	0.3
	Resid. Cl_2 Total	3.1	1.9	2.3	1.4	0.8	1.0	3.3	1.3	2.4	1.2	0.7	1.0
AUG	Cl_2 Demand												
	Cl_2 Dosage	4.5	3.9	4.2				5.0	4.6	4.8			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.7	1.8	2.3	1.3	0.7	0.9	2.3	1.7	2.1	1.0	0.6	0.7
	Resid. Cl_2 Comb.	0.5	0.2	0.4	0.3	0.2	0.2	0.6	0.3	0.5	0.4	0.2	0.4
	Resid. Cl_2 Total	3.0	2.1	2.6	1.5	0.9	1.1	2.8	2.1	2.5	1.3	0.7	1.1
SEP	Cl_2 Demand												
	Cl_2 Dosage	4.2	3.3	3.5				4.4	3.8	4.0			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.2	1.4	1.8	0.9	0.4	0.7	2.3	1.2	1.9	1.0	0.5	0.8
	Resid. Cl_2 Comb.	0.5	0.3	0.4	0.3	0.2	0.2	0.5	0.3	0.4	0.4	0.2	0.3
	Resid. Cl_2 Total	2.6	1.8	2.2	1.2	0.7	1.0	2.8	1.6	2.3	1.4	0.7	1.1

TABLE 3.0 (cont'd.)

		1986						1985					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand												
	Cl_2 Dosage	3.3	2.8	3.1				3.8	2.8	3.0			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.4	1.2	1.7	1.2	0.6	0.8	2.4	1.4	1.7	1.0	0.7	0.8
	Resid. Cl_2 Comb.	0.4	0.2	0.3	0.3	0.1	0.2	0.5	0.2	0.5	0.4	0.2	0.2
	Resid. Cl_2 Total	2.5	1.4	2.0	1.4	0.8	1.1	2.7	1.6	2.1	1.3	1.0	1.1
NOV	Cl_2 Demand												
	Cl_2 Dosage							3.3	2.5	2.8			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.0	1.3	1.6	1.0	0.6	0.9	1.8	1.2	1.5	1.0	0.5	0.8
	Resid. Cl_2 Comb.	0.4	0.2	0.3	0.3	0.1	0.2	0.4	0.2	0.3	0.3	0.1	0.2
	Resid. Cl_2 Total	2.4	1.6	1.9	1.4	0.7	1.1	2.1	1.5	1.8	1.2	0.7	1.0
DEC	Cl_2 Demand												
	Cl_2 Dosage							3.5	3.0	3.1			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free							1.8	1.1	1.4	1.0	0.5	0.8
	Resid. Cl_2 Comb.							0.4	0.2	0.3	0.3	0.2	0.2
	Resid. Cl_2 Total							2.1	1.4	1.7	1.2	0.8	1.0

TABLE 3.1: DISINFECTION SUMMARY

WPOS - BELLEVILLE WTP

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand												
	Cl_2 Dosage	3.3	2.5	2.8				3.0	2.9	2.9			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.6	1.2	1.3	0.9	0.5	0.7	1.7	1.0	1.4	0.9	0.6	0.7
	Resid. Cl_2 Comb.	0.6	0.2	0.4	0.5	0.2	0.3	0.8	0.2	0.4	0.4	0.2	0.3
	Resid. Cl_2 Total	2.1	1.4	1.7	1.2	0.8	1.0	2.2	1.5	1.8	1.3	0.9	1.0
FEB	Cl_2 Demand												
	Cl_2 Dosage	4.5	3.0	3.6				3.3	2.9	3.0			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.8	0.8	1.3	1.1	0.2	0.8	1.7	0.6	1.4	0.9	0.6	0.7
	Resid. Cl_2 Comb.	0.9	0.2	0.4	0.8	0.2	0.3	1.1	0.3	0.5	0.5	0.2	0.3
	Resid. Cl_2 Total	2.2	1.2	1.7	1.5	0.7	1.1	2.3	1.5	1.9	1.3	0.8	1.0
MAR	Cl_2 Demand												
	Cl_2 Dosage	3.4	3.0	3.3				3.4	3.0	3.1			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.6	1.1	1.3	1.0	0.7	0.8	1.8	1.2	1.6	1.1	0.6	0.8
	Resid. Cl_2 Comb.	0.6	0.2	0.3	0.4	0.1	0.2	0.6	0.2	0.4	0.4	0.2	0.3
	Resid. Cl_2 Total	2.1	1.4	1.6	1.3	0.9	1.0	2.3	1.5	1.9	1.3	0.9	1.1

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand												
	Cl_2 Dosage	3.3	2.9	3.2				3.0	3.0	3.0			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.7	1.2	1.5	1.0	0.6	0.8	1.7	1.3	1.5	0.9	0.7	0.8
	Resid. Cl_2 Comb.	0.4	0.1	0.3	0.4	0.1	0.3	0.7	0.2	0.4	0.3	0.2	0.2
	Resid. Cl_2 Total	2.0	1.3	1.7	1.2	0.8	1.0	2.1	1.6	1.8	1.2	0.9	1.0
MAY	Cl_2 Demand												
	Cl_2 Dosage	4.3	3.3	3.8				4.0	3.0	3.6			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.2	1.2	1.7	1.1	0.5	0.8	1.9	1.2	1.6	1.0	0.5	0.7
	Resid. Cl_2 Comb.	0.6	0.2	0.4	0.3	0.2	0.2	0.6	0.3	0.4	0.3	0.2	0.3
	Resid. Cl_2 Total	2.6	1.5	2.0	1.3	0.7	1.0	2.4	1.6	2.0	1.2	0.8	1.0
JUN	Cl_2 Demand												
	Cl_2 Dosage	5.0	4.0	4.2				5.3	4.0	4.5			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.2	1.6	1.8	1.0	0.4	0.8	2.6	1.2	1.9	1.0	0.5	0.8
	Resid. Cl_2 Comb.	1.3	0.2	0.5	0.3	0.2	0.2	0.8	0.2	0.5	0.5	0.2	0.3
	Resid. Cl_2 Total	3.4	1.8	2.2	1.2	0.7	1.0	3.3	1.6	2.4	1.3	0.8	1.0

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand												
	Cl_2 Dosage	5.3	4.5	4.9				5.0	4.5	4.6			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	3.1	1.5	2.2	1.1	0.4	0.8	2.7	1.2	2.0	1.0	0.5	0.8
	Resid. Cl_2 Comb.	0.7	0.3	0.5	0.5	0.2	0.3	1.1	0.3	0.6	0.5	0.2	0.3
	Resid. Cl_2 Total	3.6	2.1	2.7	1.4	0.8	1.1	3.1	1.8	2.6	1.5	0.9	1.1
AUG	Cl_2 Demand												
	Cl_2 Dosage	5.8	4.3	5.1				5.8	4.5	4.8			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	3.0	1.1	2.0	1.0	0.3	0.7	3.7	1.3	1.9	1.0	0.3	0.7
	Resid. Cl_2 Comb.	0.8	0.3	0.5	0.4	0.2	0.3	0.8	0.4	0.5	0.5	0.3	0.4
	Resid. Cl_2 Total	3.7	1.5	2.6	1.4	0.6	1.0	4.3	1.8	2.5	1.5	0.7	1.0
SEP	Cl_2 Demand												
	Cl_2 Dosage	4.8	3.3	3.8				5.0	4.0	4.5			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.3	1.6	1.9	1.1	0.7	0.8	2.5	0.6	1.9	1.7	0.6	0.8
	Resid. Cl_2 Comb.	0.6	0.2	0.4	0.4	0.1	0.3	1.3	0.4	0.6	0.5	0.2	0.3
	Resid. Cl_2 Total	2.8	2.0	2.3	1.3	0.9	1.1	3.5	1.0	2.5	2.2	1.0	1.1

TABLE 3.1 (cont'd.)

		1984						1983					
		PRE-CHLORINATION			POST-CHLORINATION			PRE-CHLORINATION			POST-CHLORINATION		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand												
	Cl_2 Dosage	3.5	3.0	3.2				4.2	2.9	3.5			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	2.0	1.4	1.7	1.0	0.5	0.8	2.3	1.4	1.8	1.1	0.6	0.9
	Resid. Cl_2 Comb.	0.5	0.20	0.4	0.4	0.2	0.3	0.8	0.2	0.5	0.4	0.2	0.3
	Resid. Cl_2 Total	2.4	1.8	2.1	1.3	0.9	1.0	3.1	1.8	2.3	1.4	1.0	1.2
NOV	Cl_2 Demand												
	Cl_2 Dosage	3.5	2.5	2.9				3.0	2.6	2.8			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.8	1.2	1.5	1.1	0.6	0.8	1.8	1.3	1.5	1.1	0.6	0.8
	Resid. Cl_2 Comb.	0.7	0.2	0.4	0.4	0.2	0.3	0.5	0.3	0.4	0.5	0.2	0.3
	Resid. Cl_2 Total	2.5	1.6	1.9	1.4	0.8	1.1	2.3	1.7	1.9	1.4	0.8	1.2
DEC	Cl_2 Demand												
	Cl_2 Dosage	2.9	2.3	2.4				2.6	2.3	2.5			
	Ammonia												
	SO_2												
	Resid. Cl_2 Free	1.8	1.1	1.5	1.1	0.5	0.8	1.8	1.0	1.4	1.0	0.6	0.8
	Resid. Cl_2 Comb.	0.5	0.3	0.3	0.4	0.2	0.3	0.5	0.3	0.4	0.4	0.2	0.3
	Resid. Cl_2 Total	2.2	1.4	1.8	1.3	0.8	1.0	2.2	1.3	1.7	1.4	0.9	1.1

TABLE 3.2: DISINFECTION PROFILE (SEPT. 1986)

WPOS - BELLEVILLE WTP

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
1		3.5			1.65	0.32	1.97					0.66	0.16	0.82
2		3.75			1.54	0.32	1.86					0.60	0.22	0.82
3		4.0			1.52	0.37	1.89					0.40	0.31	0.71
4		4.2			2.19	0.42	2.61					0.82	0.24	1.06
5		3.75			1.89	0.33	2.22					0.72	0.22	0.94
6		3.75			1.98	0.42	2.40					0.73	0.28	1.01
7		3.75			2.00	0.37	2.37					0.80	0.27	1.07
8		3.75			1.87	0.37	2.24					0.74	0.25	0.99
9		3.75			2.12	0.43	2.55					0.90	0.22	1.12
10		3.75			1.79	0.43	2.22					0.79	0.21	1.00
11		3.75			1.90	0.41	2.31					0.82	0.24	1.06
12		3.75			1.80	0.36	2.16					0.80	0.24	1.04
13		3.75			2.05	0.53	2.58					0.78	0.34	1.12
14		3.75			2.00	0.42	2.42					0.83	0.32	1.15
15		3.6			1.87	0.40	2.27					0.72	0.23	0.95

TABLE 3.2 (SEPT. 1986)(cont'd.)

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
16		3.6			1.91	0.43	2.34					0.86	0.30	1.16
17		3.4			2.12	0.40	2.52					0.82	0.21	1.03
18		3.25			1.79	0.32	2.11					0.70	0.25	0.95
19		3.25			1.72	0.28	2.00					0.75	0.25	1.00
20		3.25			1.65	0.37	2.02					0.62	0.21	0.83
21		3.25			1.87	0.41	2.28					0.78	0.25	1.03
22		3.25			1.67	0.37	2.06					0.84	0.18	1.02
23		3.25			1.79	0.37	2.16					0.76	0.20	0.96
24		3.25			1.77	0.41	2.18					0.81	0.18	0.99
25		3.25			1.65	0.50	2.15					0.80	0.22	1.02
26		3.25			1.86	0.39	2.25					0.86	0.24	1.10
27		3.25			1.54	0.34	1.88					0.74	0.24	0.98
28		3.25			1.80	0.38	2.18					0.82	0.28	1.10
29		3.25			1.73	0.39	2.12					0.79	0.21	1.00
30		3.25			1.40	0.40	1.80					0.80	0.28	1.08

TABLE 3.3: DISINFECTION PROFILE (AUG.1986)

WPOS - BELLEVILLE WTP

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
1		4.5			2.67	0.29	2.96					1.02	0.18	1.20
2		4.5			2.36	0.28	2.64					0.88	0.24	1.12
3		4.5			2.46	0.24	2.70					1.04	0.20	1.24
4		4.5			2.52	0.47	2.99					1.18	0.22	1.40
5		4.3			2.40	0.36	2.76					1.03	0.19	1.22
6		4.3			2.38	0.40	2.73					0.97	0.22	1.19
7		4.3			2.30	0.42	2.72					0.90	0.22	1.12
8		4.3			2.19	0.40	2.59					0.89	0.18	1.07
9		4.3			2.35	0.40	2.75					0.90	0.28	1.18
10		4.3			2.32	0.46	2.78					0.91	0.31	1.22
11		4.2			2.21	0.36	2.57					0.85	0.17	1.02
12		4.2			2.30	0.30	2.60					0.82	0.20	1.02
13		4.2			2.29	0.41	2.70					0.99	0.20	1.19
14		4.2			2.10	0.31	2.41					0.89	0.23	1.12
15		4.2			2.07	0.39	2.46					0.76	0.23	0.99

TABLE 3.3 (AUG. 1986)(cont'd.)

DATE	PRE-CHLORINATION							POST-CHLORINATION						
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2		
	Dem.	Dos.			Free	Comb.	Total	Dem.	Dos.			Free	Comb.	Total
16		4.2			2.10	0.40	2.50					0.81	0.30	1.11
17		4.2			2.26	0.44	2.70					0.70	0.31	1.01
18		4.2			1.76	0.36	2.12					0.67	0.23	0.90
19		4.2			2.20	0.42	2.62					0.65	0.22	0.87
20		4.2			2.02	0.42	2.44					0.69	0.20	0.89
21		4.2			2.01	0.40	2.41					0.78	0.19	0.97
22		4.2			2.19	0.41	2.60					0.80	0.19	0.99
23		4.2			2.11	0.38	2.49					0.74	0.26	1.00
24		4.2			2.42	0.36	2.78					0.89	0.21	1.10
25		4.2			2.25	0.36	2.61					1.02	0.20	1.22
26		4.2			2.33	0.42	2.75					0.83	0.31	1.14
27		4.2			2.24	0.41	2.65					0.81	0.25	1.06
28		4.1			2.52	0.41	2.93					0.87	0.16	1.03
29		4.0			2.32	0.38	2.70					0.97	0.21	1.18
30		3.9			2.00	0.34	2.34					1.28	0.20	1.48

TABLE 4.0: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION SUMMARY

WPOS BELLEVILLE WTP

			1986			1985			1984			1983		
			MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.
JAN	PAC													
	$KMnO_4$													
	Ton	R	<5	10	7	10	<40	21	5	9	7	8	8	8
		T	2	4	3	4	10	7	5	10	7	5	6	6
	F Dos.		1.16	1.29	1.23	1.26	1.30	1.28	1.02	1.11	1.05	1.02	1.08	1.06
	F Res.		1.16	1.24	1.17	1.11	1.24	1.18	0.90	1.21	0.99	0.97	1.05	1.00
FEB	PAC													
	$KMnO_4$													
	Ton	R	2	4	3	3	8	6	5	>10	7	10	>40	22
		T	2	3	3	2	6	4	7	>20	12	4	6	5
	F Dos.		1.25	1.34	1.28	1.25	1.41	1.33	1.09	1.14	1.11	1.03	1.11	1.08
	F Res.		1.16	1.31	1.22	1.14	1.25	1.20	0.89	1.03	0.96	0.92	1.18	1.00
MAR	PAC													
	$KMnO_4$													
	Ton	R	1	4	3	4	>20	10	5	9	6	20	40	29
		T	1	>6	3	3	15	10	5	7	6	7	>16	11
	F Dos.		1.00	1.31	1.10	1.31	1.40	1.37	1.09	1.16	1.13	1.01	1.08	1.05
	F Res.		1.10	1.34	1.19	1.14	1.28	1.20	0.96	1.06	1.02	0.94	1.02	0.98
APR	PAC													
	$KMnO_4$													
	Ton	R	6	100	30	15	60	36	5	135	42	25	75	45
		T	2	8	5	7	20	13	6	>33	20	17	40	26
	F Dos.		1.01	1.14	1.11	1.25	1.34	1.30	1.03	1.15	1.10	1.00	1.07	1.05
	F Res.		1.10	1.27	1.22	1.12	1.26	1.18	0.86	1.08	1.01	0.95	1.00	0.98
MAY	PAC													
	$KMnO_4$													
	Ton	R	50	115	88	140	200	188	200	>400	280	100	>200	170
		T	5	7	6	7	30	15	7	13	9	23	40	33
	F Dos.		1.02	1.30	1.16	1.28	1.35	1.30	1.00	1.10	1.03	0.99	1.08	1.05
	F Res.		1.09	1.30	1.12	1.14	1.33	1.18	0.89	1.08	1.00	0.90	1.03	0.97
JUN	PAC													
	$KMnO_4$													
	Ton	R	35	40	38	200	200	200	400	400	400	150	>200	190
		T	4	8	7	8	10	9	5	11	8	10	23	15
	F Dos.		1.16	1.28	1.20	1.21	1.36	1.27	0.96	1.08	1.02	0.98	1.12	1.08
	F Res.						1.41	1.3			1.0			1.1

		1986			1985			1984			1983		
		MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.	MIN.	MAX.	AVG.
JUL	PAC												
	$KMnO_4$												
	Ton R	65	100	83	200	200	200	400	400	400	>200	>200	>200
	T	6	10	8	7	12	10	10	14	13	9	9	9
	F Dos.	1.04	1.26	1.18	1.19	1.25	1.22	0.98	1.34	1.08	0.95	1.18	1.05
	F Res.	1.07	1.31	1.21	1.14	1.26	1.20	0.95	1.30	1.07	0.95	1.05	0.99
AUG	PAC												
	$KMnO_4$												
	Ton R	45	70	55	200	200	200	100	>400	230	200	>200	200
	T	6	15	10	10	18	16	10	25	16	13	15	14
	F Dos.	1.12	1.25	1.18	1.15	1.24	1.20	0.90	1.43	1.26	1.01	1.06	1.04
	F Res.	1.09	1.25	1.16	1.13	1.21	1.17	0.80	1.25	1.10	0.96	1.07	1.00
SEP	PAC												
	$KMnO_4$												
	Ton R	30	45	41	200	200	200	>400	>400	>400	200	>200	200
	T	6	15	10	9	10	10	15	19	17	30	80	40
	F Dos.	1.14	1.35	1.20	1.12	1.25	1.20	1.33	1.43	1.37	0.97	1.07	1.02
	F Res.	1.12	1.29	1.19	1.15	1.27	1.21	1.06	1.36	1.21	0.94	1.07	0.98
OCT	PAC												
	$KMnO_4$												
	Ton R	8	150	57	200	200	200	200	400	350	200	>200	200
	T	8	40	18	6	18	12	9	17	12	10	40	21
	F Dos.	1.20	1.30	1.24	1.19	1.24	1.22	1.35	1.40	1.37	0.98	1.08	1.03
	F Res.	1.11	1.25	1.20	1.10	1.26	1.22	1.19	1.27	1.22	0.86	1.04	0.98
NOV	PAC												
	$KMnO_4$												
	Ton R				60	200	143	75	400	235	200	>200	200
	T				3	6	5	6	8	8	5	9	6
	F Dos.	1.23	1.32	1.26	1.18	1.24	1.21	1.28	1.38	1.32	0.95	1.14	1.04
	F Res.	1.14	1.28	1.20	1.15	1.24	1.19	1.14	1.28	1.22	0.90	1.15	0.98
DEC	PAC												
	$KMnO_4$												
	Ton R				15	69	34	80	>200	140	200	200	200
	T				3	4	4	5	5	5	5	5	5
	F Dos.				1.19	1.26	1.22	1.14	1.37	1.26	0.97	1.09	1.08
	F Res.				1.01	1.24	1.17	1.14	1.29	1.19	1.01	1.15	1.08

NOTE: Fluoride dosages and residuals are in mg/L.

TABLE 4.1: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (AUG.1984)

WPOS - BELLEVILLE WTP

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE		TON	
						Dosage	Residual	R	T
1						0.90	1.00	400	10-40
2						1.02	0.80		
3						1.16	0.91	100	10-20
4						1.21	1.08		
5						1.21	1.04		
6						1.21	1.04		
7						1.20	0.89		
8						1.21	1.14	100-200	10
9						1.20	1.10		
10						1.21	1.08		
11						1.20	1.08		
12						1.15	1.08		
13						1.19	1.04		
14						1.22	1.02		
15						1.22	1.02	100-200	10-20

TABLE 4.1 (cont'd.)

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE		TON	
						Dosage	Residual	R	T
16						1.32	1.05		
17						1.37	NA		
18						1.31	NA		
19						1.33	NA		
20						1.38	1.10		
21						1.42	1.20		
22						1.41	1.25		
23						1.39	1.25		
24						1.38	1.20	200^+	10
25						1.39	1.25		
26						1.38	1.25		
27						1.38	1.20		
28						1.43	1.14		
29						1.41	1.20	400^+	10-25
30						1.38	1.12		
31						1.41	1.11		

NA = Data not available

TABLE 4.2: T&O CONTROL, ALKALINITY ADJ. & FLUORIDATION PROFILE (SEPT.1984)

WPOS - BELLEVILLE WTP

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE		TON	
						Dosage	Residual	R	T
1						1.40	1.21		
2						1.40	1.20		
3						1.41	1.21		
4						1.40	1.17		
5						1.43	1.26		
6						1.39	1.24	400^+	10-20
7						1.38	1.20		
8						1.36	1.20		
9						1.37	1.21		
10						1.38	1.20		
11						1.38	1.20		
12						1.38	1.20	400^+	13-25
13						1.36	1.25		
14						1.37	1.19		
15						1.35	1.25		

TABLE 4.2 (cont'd.)

DATE	PAC	$KMnO_4$	LIME	SODA ASH	$NaHCO_3$	FLUORIDE		TON	
						Dosage	Residual	R	T
16						1.37	1.34		
17						1.38	1.20		
18						1.36	1.24		
19						1.38	1.23	400+	10-25
20						1.36	1.25		
21						1.35	1.36		
22						1.33	1.24		
23						1.35	1.23		
24						1.33	1.13		
25						1.36	1.13		
26						1.38	1.30	400^+	13-20
27						1.37	1.16		
28						1.37	1.16		
29						1.35	1.06		
30						1.38	1.16		
31									

WPOS - BELLEVILLE WTP

GENERAL CHEMISTRY		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
GENERAL CHEMISTRY -(1)															
Alkalinity (mg/L)	R	121	97	106	135	103	117			115	140	94	109	0.2 (mg/L)	
	T	97	74	84	109	75	92			88	123	75	93		
Ammonium (Total) (mg/L)	R	0.06	-	-			-			-			-	0.05 (mg/L)	
	T			-			-			-			-		
Calcium (mg/L)	R			40.0	47.0	41.0	42.5			36				0.1 (mg/L)	
	T			40.5	46.0	40.0	42.3			40					
Chloride (mg/L)	R	13.3	8.3	10.2	12.0	7.8	9.7			11			9.3	0.2 (mg/L)	250 (mg/L)
	T	15.0	11.0	13.2	16.0	11.0	13.3			14			13.0		
Colour (TCU)	R	30	21	28	53	15	28	47	12	27	43	20	27	0.5 (TCU)	5 (TCU)
	T	7	0	3	11	0	4	9	1	4	20	1	7		
Conductivity (umho/cm)	R	280	230	251	305	245	268	285	215	247	306	224	267	0.01 (umho/cm)	
	T	285	242	263	310	265	284	240	235	260	300	233	271		
Field Chlorine (Combined)	R													0.1 (mg/L)	
	T														
Field Chlorine (Free)	R													0.1 (mg/L)	
	T														
Field Chlorine (Total)	R													0.1 (mg/L)	
	T														
Field pH	R													0.2	
	T														

(1) General Chemistry test results are obtained from monthly MOE chemical testing program.
Bacteriological test results are obtained from weekly MOE testing program.
Metals testing is carried out bi-annually by the MOE. Trihalomethane testing is carried out monthly by the MOE.

GENERAL CHEMISTRY (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Field Temperature (^{O}C)	R														
	T														
Field Turbidity (FTU)	R														1 (FTU)
	T														
Fluoride (mg/L)	R	0.31	-	0.10	0.21	-	0.13	0.16		0.09	0.30	-	0.17	0.01 (mg/L)	2.4 (mg/L)
	T	1.05	0.68	0.90	1.20	0.80	1.02	1.19	0.7	1.03	1.30	0.63	1.05		
Hardness (mg/L)	R	130	104	119	148	116	128			106				0.5 (mg/L)	
	T	140	106	120	148	118	127			116					
Magnesium (mg/L)	R	5.60	4.25	5.00	4.40	4.10	4.2	4.00	3.30	3.7			4.0	0.05 (mg/L)	c
	T	5.40	4.15	4.80	4.50	3.90	4.2	4.00	3.50	3.8			4.0		
Nitrate (mg/L)	R	0.34	-	0.27			0.06			-			-	0.05 (mg/L)	10 (mg/L as N)
	T	0.40	-	0.26	0.26	-	0.15			-			-		
Nitrite (mg/L)	R	0.006	-	-	0.058	-	0.030			-			-	0.005 (mg/L)	1 (mg/L as N)
	T	-	-	-			-			-			-		
Nitrogen Total Kjeldahl (mg/L)	R													0.1 (mg/L)	0.15 (mg/L) *
	T														
pH	R	8.2	7.6	7.7	8.2	7.8	8.0			7.9	8.2	7.9	8.1		
	T	7.9	6.8	7.2	7.5	6.9	7.3			7.3	7.8	7.0	7.4		
Phosphorus Filtered Reactive (mg/L)	R						-							0.01 (mg/L)	
	T						-								

GENERAL CHEMISTRY (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Phosphorus (Total) (mg/L)	R													0.01 (mg/L)	
	T														
Sodium (mg/L)	R													0.1 (mg/L)	
	T														
Total Solids (mg/L)	R													1 (mg/L)	
	T														
Turbidity (FTU)	R	8.4	0.85	3.5	18.0	1.2	4.6	6.1	1.2	3.3	2.4	0.42	1.5	0.01 (FTU)	1 (FTU)
	T	0.95	0.20	0.50	0.78	0.10	0.43	2.2	0.3	0.65	0.80	0.30	0.51		
METALS															
Aluminum (mg/L)	R	0.150	0.083	0.121	0.100	0.031	0.08	0.140	0.040	0.09				0.003 (mg/L)	0.100 (mg/L) G
	T	0.45	0.15	0.28	0.260	0.14	0.19	0.170	0.140	0.155					
Arsenic (mg/L)	R			-			-							0.001 (mg/L)	0.05 (mg/L)
	T			-			-								
Barium (mg/L)	R	0.032	0.027	0.029	0.028	0.021	0.024	0.031	0.025	0.028				0.001 (mg/L)	1 (mg/L)
	T	0.031	0.030	0.030	0.024	0.022	0.023	0.030	0.024	0.027					
Beryllium (mg/L)	R													0.001 (mg/L)	
	T														
Boron (mg/L)	R	0.05	-	0.03			-			0.03				0.02 (mg/L)	5 (mg/L)
	T	0.03	-	-			-			0.03					
Cadmium (mg/L)	R			-			-			-				0.0003 (mg/L)	0.005 (mg/L)
	T			-			-			0.005					

METALS (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Chromium (mg/L)	R	-	-	-	0.014	-	0.006	-	-	-				0.001 (mg/L)	0.05 (mg/L)
	T	-	-	-	0.016	-	0.006	0.002	-	0.002					
Cobalt (mg/L)	R	-	-	-	-	-	-	-	-	-				0.001 (mg/L)	
	T	-	-	-		-	-	0.002	-	0.002					
Copper (mg/L)	R	0.010	0.004	0.007	0.004	0.003	0.003	0.006	-	0.004				0.001 (mg/L)	1 (mg/L)
	T	0.020	0.011	0.015	0.006	0.005	0.006	0.009	0.002	0.006					
Cyanide (mg/L)	R	-	-	-	-	-	-	-	-	-				0.001 (mg/L)	0.2 (mg/L)
	T	-	-	-	-	-	-	0.002	-	0.001					
Iron (mg/L)	R	0.30	0.01	0.177	0.19	0.07	0.113	0.086	-	0.044				0.002 (mg/L)	0.3 (mg/L) c
	T	0.13	0.01	0.067	0.04	0.03	0.033	0.004	-	0.003					
Lead (mg/L)	R	-	-	-	-	-	-	-	-	-				0.003 (mg/L)	0.05 (mg/L)
	T	0.005	-	0.004	-	-	-	0.008	-	0.004					
Manganese (mg/L)	R	0.060	0.010	0.029	0.04	0.015	0.023	3.300	0.009	1.75				0.001 (mg/L)	0.05 (mg/L)
	T	0.010	0.003	0.005	0.008	0.005	0.006	3.500	-	1.75					
Molybdenum (mg/L)	R	-	-	-	-	-	-	-	-	-				0.001 (mg/L)	
	T	0.002	-	0.001	-	-	-	-	-	-					
Mercury (ug/L)	R	0.05	0.03	0.04	0.36	-	0.147	0.09	0.08	0.085				0.01 (ug/L)	1 (ug/L)
	T	0.1	0.04	0.06	0.39	-	0.167	0.09	0.09	0.09					
Nickel (mg/L)	R	-	-	-	-	-	-	-	-	-				0.002 (mg/L)	
	T	-	-	-	-	-	-	0.003	-	0.002					

METALS (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Selenium (mg/L)	R			-			-							0.001 (mg/L)	0.01 (mg/L)
	T			-			-								
Strontium (mg/L)	R	0.110	0.082	0.095	0.130	0.098	0.113	0.130	0.078	0.109				0.001 (mg/L)	
	T	0.110	0.099	0.103	0.140	0.074	0.108	0.130	0.100	0.115					
Tin (no units available)	R														
	T														
Uranium (mg/L)	R													0.002 (mg/L)	0.02 (mg/L) t
	T														
Vanadium (mg/L)	R			-			-			-				0.001 (mg/L)	
	T			-			-			-					
Zinc (mg/L)	R	0.007	0.005	0.006			-	0.005	0.002	0.004				0.001 (mg/L)	5 (mg/L) h
	T	0.006	0.003	0.009			-			0.002					
PURGEABLES															
Benzene (ug/L)	R													1 (ug/L)	10 (ug/L) h
	T														
Bromoform (ug/L)	R													1 (ug/L)	350 (ug/L) ++
	T														
Carbon Tetrachloride (ug/L)	R													1 (ug/L)	3 (ug/L) h
	T														
Chlorobenzene (ug/L)	R													1 (ug/L)	100-300 (ng/L) h*
	T														

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Chlorodibromomethane (ug/L)	R						-			-			-	1 (ug/L)	350 (ug/L) ++
	T						-			-			-		
Chloroform (ug/L)	R						-			-			-	1 (ug/L)	350 (ug/L) ++
	T				132	81	108	166	78	123	204	102	158		
1,2-Dichlorobenzene (ug/L)	R													1 (ug/L)	400 (ug/L) e
	T														
1,3-Dichlorobenzene (ug/L)	R													1 (ug/L)	400 (ug/L) e
	T														
1,4-Dichlorobenzene (ug/L)	R													1 (ug/L)	400 (ug/L) e
	T														
Dichlorobromomethane (ug/L)	R						-			-			-	1 (ug/L)	350 (ug/L) ++
	T				12	7	9	13	4	8	20	5	12		
1,1-Dichloroethane (ug/L)	R													1 (ug/L)	
	T														
1,2-Dichloroethane (ug/L)	R													1 (ug/L)	10 (ug/L) h
	T														
1,1-Dichloroethylene (ug/L)	R													1 (ug/L)	0.3 (ug/L) h
	T														
T,1,2-Dichloroethylene (ug/L)	R													1 (ug/L)	
	T														

TABLE 5.0 (cont'd.)

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
Dichloromethane (ug/L)	R T													5 (ug/L)	40 (ug/L)
1,2-Dichloropropane (ug/L)	R T													1 (ug/L)	
Ethylbenzene (ug/L)	R T													1 (ug/L)	1400 (ug/L)
Ethylene Dibromide (ug/L)	R T														
M-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L) c
O-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L) c
P-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L) c
Toluene (ug/L)	R T													1 (ug/L)	100 (ug/L) c
1,1,2,2-Tetra-chloroethane (ug/L)	R T													1 (ug/L)	1.7 (ug/L) e
Tetrachloroethane (ug/L)	R T													1 (ug/L)	10 (ug/L) h

PURGEABLES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
1,1,1-Trichloroethane (ug/L)	R													1 (ug/L)	1000 (ug/L) c
	T														
1,1,2-Trichloroethane (ug/L)	R													1 (ug/L)	6 (ug/L) e
	T														
Trichloroethylene (ug/L)	R													1 (ug/L)	30 (ug/L) h
	T														
Total Trihalomethanes (ug/L)	R						-			-			-	3 (ug/L)	350 (ug/L) ++
	T				139	88	112	179	83	131	213	107	170		
Trifluorochloro-toluene (ug/L)	R													1 (ug/L)	
	T														
ORGANOCHLORINES															
Aldrin (ng/L)	R													1 (ng/L)	700 (ng/L) **
	T														
Alpha BHC (ng/L)	R													1 (ng/L)	700 (ng/L) c
	T														
Alpha Chlordane (ng/L)	R													2 (ng/L)	700 (ng/L) ***
	T														
Beta BHC (ng/L)	R													1 (ng/L)	300 (ng/L) c
	T														
Dieldrin (ng/L)	R													2 (ng/L)	700 (ng/L) **
	T														

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Endrin (ng/L)	R T													4 (ng/L)	200 (ng/L)
Gamma Chlordane (ng/L)	R T													2 (ng/L)	700 (ng/L) ***
Heptachlor Epoxide (ng/L)	R T													1 (ng/L)	3000 (ng/L) +++
Heptachlor (ng/L)	R T													1 (ng/L)	3000 (ng/L) +++
Hexachlorobenzene (ng/L)	R T													1 (ng/L)	10 (ng/L) h
Hexachlorobutadiene (ug/L)	R T													1 (ng/L)	
Hexachloroethane (ng/L)	R T													1 (ng/L)	19000 (ng/L) e
Lindane (ng/L)	R T													1 (ng/L)	4000 (ng/L)
Methoxychlor (ng/L)	R T													5 (ng/L)	100000 (ng/L)
Mirex (ng/L)	R T													5 (ng/L)	

ORGANOCHLORINES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Octachlorostyrene (ng/L)	R													1 (ng/L)	
	T														
O,P-DDT (ng/L)	R													5 (ng/L)	30000 (ng/L) d
	T														
Oxychlordane (ng/L)	R													2 (ng/L)	
	T														
PCB Total (ng/L)	R													20 (ng/L)	3000 (ng/L) t
	T														
Pentachlorobenzene (ng/L)	R													1 (ng/L)	74000 (ng/L) e
	T														
P,P-DDD (ng/L)	R													5 (ng/L)	d
	T														
P,P-DDE (ng/L)	R													1 (ng/L)	d
	T														
P,P-DDT (ng/L)	R													5 (ng/L)	d
	T														
1,2,3,4-Tetra-chlorobenzene (ng/L)	R													1 (ng/L)	
	T														
1,2,3,5-Tetra-chlorobenzene (ng/L)	R													1 (ng/L)	
	T														

ORGANOCHLORINES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
1,2,4,5-Tetra-chlorobenzene (ng/L)	R T													1 (ng/L)	38000 (ng/L) e
Thiodan I (ng/L)	R T													2 (ng/L)	74000 (ng/L) ea
Thiodan II (ng/L)	R T													4 (ng/L)	74000 (ng/L) ea
Thiodan Sulphate (ng/L)	R T													4 (ng/L)	
Toxaphene (no units available)	R T														
1,2,3-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L) y
1,2,4-Trichlorobenzene (ng/L)	R T													5 (ng/L)	15000 (ng/L) y
1,3,5-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L) y
2,3,6-Trichlorotoluene (ng/L)	R T													5 (ng/L)	
2,4,5-Trichlorotoluene (ng/L)	R T													5 (ng/L)	10000 (ng/L) g

TRIAZINES		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
TRIAZINES															
2,6,A-Trichlorotoluene (ng/L)	R T													5 (ng/L)	
Alachlor (ng/L)	R T														
Ametrine (ng/L)	R T													50 (ng/L)	
Atratone (ng/L)	R T													50 (ng/L)	
Atrazine (ng/L)	R T													50 (ng/L)	46000 (ng/L) !
Bladex (ng/L)	R T													100 (ng/L)	10000 (ng/L) !
Metolachlor (ng/L)	R T														
Prometone (ng/L)	R T													50 (ng/L)	
Prometryne (ng/L)	R T													50 (ng/L)	1000 (ng/L) !
Propazine (ng/L)	R T													50 (ng/L)	

TRIAZINES (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Sencor (ng/L)	R T													100 (ng/L)	
Simazine (ng/L)	R T													50 (ng/L)	10000 (ng/L) !
SPECIAL PESTICIDES															
2,4-D (ng/L)	R T													100 (ng/L)	100000 (ng/L)
2,4-D Butyric Acid (ng/L)	R T													200 (ng/L)	18000 (ng/L) !
Dicamba (ng/L)	R T													100 (ng/L)	87000 (ng/L) !
Pentachlorophenol (ng/L)	R T													50 (ng/L)	10000 (ng/L) h
Picloram (ng/L)	R T													100 (ng/L)	
2,4-D Propionic Acid (ng/L)	R T													100 (ng/L)	
Silvex (ng/L)	R T													50 (ng/L)	10000 (ng/L)
2,4,5-T (ng/L)	R T													50 (ng/L)	

SPECIAL PESTICIDES (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
2,3,4,5-Tetra-chlorophenol (ng/L)	R T													50 (ng/L)	
2,3,5,6-Tetra-chlorophenol (ng/L)	R T													50 (ng/L)	
2,3,4-Trichlorophenol (ng/L)	R T													100 (ng/L)	
2,4,5-Trichlorophenol (ng/L)	R T													50 (ng/L)	
2,4,6-Trichlorophenol (ng/L)	R T													50 (ng/L)	10000 (ng/L) h
ORGANOPHOSPHOROUS PEST'S.															
Diazinon (ng/L)	R T													50 (ng/L)	14000 (ng/L)
Dichlorovos (ng/L)	R T														
Dursban (ng/L)	R T														
Ethion (ng/L)	R T														
Guthion (ng/L)	R T														

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Malathion (ng/L)	R T														
Methylparathion (ng/L)	R T													50 (ng/L)	7000 (ng/L)
Methyltrithion (ng/L)	R T														
Mevinphos (ng/L)	R T														
Parathion (ng/L)	R T													50 (ng/L)	35000 (ng/L)
Phorbate (ng/L)	R T														
Reldan (ng/L)	R T														
Ronnel (ng/L)	R T														
MASS SPEC.															
Di-N-Butyl Phthalate (ug/L)	R T													0.1 (ug/L)	34000 (ug/L) e

TABLE 5.0 (cont'd.)

MASS SPEC. (cont'd.)		1983 MAX	1983 MIN	1983 AVG	1984 MAX	1984 MIN	1984 AVG	1985 MAX	1985 MIN	1985 AVG	1986 MAX	1986 MIN	1986 AVG	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
N-Dichloromethylene-Pentachloroanaline (ug/L)	R													0.1 (ug/L)	
	T														
Diphenyl Ether (ug/L)	R													0.1 (ug/L)	
	T														
Fluoranthene (ug/L)	R													0.1 (ug/L)	
	T														
Hexachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Methyl Phenanthrene (ug/L)	R													0.1 (ug/L)	
	T														
Naphthalene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachlorobutadiene (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropane (ug/L)	R													0.1 (ug/L)	
	T														
Pentachloropropene (ug/L)	R													0.1 (ug/L)	
	T														
Pyrene (ug/L)	R													0.1 (ug/L)	
	T														

MASS SPEC. (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Tetrachlorbutane (ug/L)	R T													0.1 (ug/L)	
Tetrachlorobiphenyl (ug/L)	R T													0.1 (ug/L)	
BACTERIA															
Raw Water:															
Total Coliform MF	R	15000	2	1130	12000	0	481	1600	2	247	2200	2	384		
Total Coliform BKGD	R														
Fecal Coliform MF (count/100 mL)	R	520	0	40	150	0	17	83	0	13	150	0	18	0	0/0.1 (mL)
Standard Plate Count MF (count/mL)	R													0	500
Treated Water:														0	
Present/Absent Test	T														
Total Coliform Background MF (count/100 mL)	T			0			0			0			0	0 0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T													0	OWDO Bacti

BACTERIA (cont'd.)		1983			1984			1985			1986			DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
		MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG		
Treated Water (cont'd.)															
Standard Plate Count MF (count/100 mL)	T														
If Present/Absent Test Positive:															
Coliform P/A	R														
	T														
Fecal Coliform P/A	R														
	T														
E. Coli P/A	R														
	T														
Aeromonas P/A	R														
	T														
Staph. Aureus P/A	R														
	T														
P/A Bottle	T														

TABLE 5.0 - FOOTNOTES

1	= see individual footnotes for agency of guideline origin
c	= California State Department of Health action level
d	= OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e	= USEPA ambient guideline
ea	= United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep	= USEPA proposed maximum contaminant level for drinking water
g	= suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h	= World Health Organization (WHO) guideline
h*	= World Health Organization (WHO) odour threshold
mg/L	= milligrams per litre, parts per million (ppm)
ng/L	= nanograms per litre, parts per trillion (ppt)
Presence/Absence	= microbiological test to indicate presence or absence of coliform bacteria
R	= raw water
T	= treated drinking water
t	= ODWO interim maximum acceptable concentration (IMAC)
ug/L	= micrograms per litre, parts per billon (ppb)
y	= New York State (taste and odour) proposed drinking water guideline
++	= total trihalomethanes
+++	= combined total: heptachlor and heptachlor epoxide
*	= if other than DWSP detection limit
**	= total of aldrin and dieldrin
***	= chlordane is a mixture of alpha and gamma isomers
!	= Ministry of the Environment and Health and Welfare Canada (IMAC)
-	= No quantifiable results. This includes readings that are non-detectable and readings that are detected but not quantifiable.
G	= ODWO suggested guideline

TABLE 5.1: WATER QUALITY (ONE-YEAR SUMMARY)

WPOS - BELLEVILLE WTP

GENERAL CHEMISTRY		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
GENERAL CHEMISTRY -(1)															
Alkalinity (mg/L)	R									115				0.2 (mg/L)	
	T									88					
Ammonium (Total) (mg/L)	R													0.05 (mg/L)	
	T														
Calcium (mg/L)	R									36				0.1 (mg/L)	
	T									40					
Chloride (mg/L)	R									11				0.2 (mg/L)	250 (mg/L)
	T									14					
Colour (TCU)	R	12	17	26	23	32	21	30	44	47	25	18		0.5 (TCU)	5 (TCU)
	T	<1		6	7	3	4	9		2	4	<1			
Conductivity (umho/cm)	R	285	250	270	255	215	235	250	255	250	230	225		0.01 (umho/cm)	
	T	290	265	285	270	230	249	265	270	255	250	235			
Field Chlorine Residual (Combined)	R													0.1 (mg/L)	
	T														
Field Chlorine Residual (Free)	R													0.1 (mg/L)	
	T														
Field Chlorine Residual (Total)	R													0.1 (mg/L)	
	T														
Field pH	R													0.2	
	T														

(1) General Chemistry test results are obtained from monthly MOE chemical testing program.
Bacteriological test results are obtained from weekly MOE testing program.
Metals testing is carried out bi-annually by the MOE. Trihalomethane testing is carried out monthly by the MOE.

GENERAL CHEMISTRY (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Field Temperature (^{o}C)	R														
	T														
Field Turbidity (FTU)	R														1 (FTU)
	T														
Fluoride (mg/L)	R	0.1	0.1	0.1	0.12	-	-		0.16		-	-		0.01 (mg/L)	2.4 (mg/L)
	T	1.1	1.1	0.7	1.1	1.1	1.19		1.0		0.85	1.1			
Hardness (mg/L)	R									106				0.5 (mg/L)	
	T									116					
Magnesium (mg/L)	R				3.30					4.00		3.70		0.05 (mg/L)	c
	T				3.50					4.00		3.75			
Nitrate (mg/L)	R													0.05 (mg/L)	10 (mg/L as N)
	T														
Nitrite (mg/L)	R													0.005 (mg/L)	1 (mg/L as N)
	T														
Nitrogen Total Kjeldahl (mg/L)	R													0.1 (mg/L)	0.15 (mg/L) *
	T														
pH	R									7.9					8.5
	T									7.3					
Phosphorus Filtered Reactive (mg/L)	R								0.038					0.01 (mg/L)	
	T								0.024						

GENERAL CHEMISTRY (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Phosphorus (Total) (mg/L)	R													0.01 (mg/L)	
	T														
Sodium (mg/L)	R													0.1 (mg/L)	
	T														
Total Solids (mg/L)	R													1 (mg/L)	
	T														
Turbidity (FTU)	R	3.0	1.2	1.7	3.5	1.8	3.5	3.2	6.1	5.5	5.0	1.7		0.01 (FTU)	1 (FTU)
	T	0.6	0.4	0.5	0.5	0.35	0.3	0.6	0.73	0.65	0.36	2.2			
METALS															
Aluminum (mg/L)	R				0.140							0.040		0.003 (mg/L)	0.100 (mg/L) G
	T				0.140							0.170			
Arsenic (mg/L)	R				-							-		0.001 (mg/L)	0.05 (mg/L)
	T				-							-			
Barium (mg/L)	R				0.025							0.031		0.001 (mg/L)	1 (mg/L)
	T				0.024							0.030			
Beryllium (mg/L)	R													0.001 (mg/L)	
	T														
Boron (mg/L)												0.03		0.02 (mg/L)	5 (mg/L)
	T											0.03			
Cadmium (mg/L)	R				-							-		0.0003 (mg/L)	0.005 (mg/L)
	T				0.005							-			

METALS (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Chromium (mg/L)	R				-							-		0.001 (mg/L)	0.05 (mg/L)
	T				0.002							-			
Cobalt (mg/L)	R				-							-		0.001 (mg/L)	
	T				0.002							-			
Copper (mg/L)	R				0.006							-		0.001 (mg/L)	1 (mg/L)
	T				0.009							.002			
Cyanide (mg/L)	R				-							-		0.001 (mg/L)	0.2 (mg/L)
	T				-							-			
Iron (mg/L)	R				-							0.086		0.002 (mg/L)	0.03 (mg/L) c
	T				-							0.004			
Lead (mg/L)	R				-							-		0.003 (mg/L)	0.05 (mg/L)
	T				0.008							-			
Manganese (mg/L)	R				3.500							0.009		0.001 (mg/L)	0.05 (mg/L)
	T				3.500							-			
Molybdenum (mg/L)	R				-							-		0.001 (mg/L)	
	T				-							-			
Mercury (ug/L)	R				0.09							0.08		0.01 (ug/L)	1 (ug/L)
	T				0.09							0.09			
Nickel (mg/L)	R				-							-		0.002 (mg/L)	
	T				0.003							-			

METALS (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Selenium	R				-							-		0.001	0.01
(mg/L)	T				-							-		(mg/L)	(mg/L)
Strontium	R				0.078							0.130		0.001	
(mg/L)	T				0.100							0.130		(mg/L)	
Tin	R														
(no units available)	T														
Uranium	R													0.002	0.02
(mg/L)	T													(mg/L)	(mg/L) t
Vanadium	R				-							-		0.001	
(mg/L)	T				-							-		(mg/L)	
Zinc	R				0.002							0.005		0.001	5
(mg/L)	T				0.002							0.002		(mg/L)	(mg/L) h
PURGEABLES															
Benzene	R													1	10
(ug/L)	T													(ug/L)	(ug/L) h
Bromoform	R													1	350
(ug/L)	T													(ug/L)	(ug/L) ++
Carbon Tetrachloride	R													1	3
(ug/L)	T													(ug/L)	(ug/L) h
Chlorobenzene	R													1	100-300
(ug/L)	T													(ug/L)	(ng/L) h*

PURGEABLES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Chlorodibromomethane (ug/L)	R	-		-	-	-	-	-		-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	-		-	-	-	-	-		-	-	-	-		
Chloroform (ug/L)	R	-		-	-	-	-	-		-	-	-	-	1 (ug/L)	350 (ug/L) ++
	T	86		78	101	147	159	166		147	132	113	97		
1,2-Dichlorobenzene (ug/L)	R													1 (ug/L)	400 (ug/L) e
	T														
1,3-Dichlorobenzene (ug/L)	R													1 (ug/L)	400 (ug/L) e
	T														
1,4-Dichlorobenzene (ug/L)	R	-		-	-	-	-	-		-	-	-	-	1 (ug/L)	400 (ug/L) e
	T	6		5	6	8	8	13		13	10	8	4		
Dichlorobromomethane (ug/L)	R													1 (ug/L)	350 (ug/L) ++
	T														
1,1-Dichloroethane (ug/L)	R													1 (ug/L)	
	T														
1,2-Dichloroethane (ug/L)	R													1 (ug/L)	10 (ug/L) h
	T														
1,1-Dichloroethylene (ug/L)	R													1 (ug/L)	0.3 (ug/L) h
	T														
T,1,2-Dichloroethylene (ug/L)	R													1 (ug/L)	
	T														

PURGEABLES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Dichloromethane (ug/L)	R T													5 (ug/L)	40 (ug/L) c
1,2-Dichloropropane (ug/L)	R T													1 6 (ug/L)	
Ethylbenzene (ug/L)	R T													1 (ug/L)	1400 (ug/L) e
Ethylene Dibromide (ug/L)	R T														
M-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L) c
O-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L) c
P-Xylene (ug/L)	R T													1 (ug/L)	620 (ug/L) c
Toluene (ug/L)	R T													1 (ug/L)	100 (ug/L) c
1,1,2,2-Tetra-chloroethane (ug/L)	R T													1 (ug/L)	1.7 (ug/L) e
Tetrachloroethane (ug/L)	R T													1 (ug/L)	10 (ug/L) h

PURGEABLES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
1,1,1-Trichloroethane (ug/L)	R													1 (ug/L)	1000 (ug/L) c
	T														
1,1,2-Trichloroethane (ug/L)	R													1 (ug/L)	6 (ug/L) e
	T														
Trichloroethylene (ug/L)	R													1 (ug/L)	30 (ug/L) h
	T														
Total Trihalomethanes (ug/L)	R	-		-	-	-	-	-		-	-	-	-	3 (ug/L)	350 (ug/L) ++
	T	92		83	107	155	167	179		160	142	121	101		
Trifluorochloro-toluene (ug/L)	R													1 (ug/L)	
	T														
ORGANOCHLORINES															
Aldrin (ng/L)	R													1 (ng/L)	700 (ng/L) **
	T														
Alpha BHC (ng/L)	R													1 (ng/L)	700 (ng/L) c
	T														
Alpha Chlordane (ng/L)	R													2 (ng/L)	700 (ng/L) ***
	T														
Beta BHC (ng/L)	R													1 (ng/L)	300 (ng/L) c
	T														
Dieldrin (ng/L)	R													2 (ng/L)	700 (ng/L) **
	T														

ORGANOCHLORINES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Endrin (ng/L)	R T													4 (ng/L)	200 (ng/L)
Gamma Chlordane (ng/L)	R T													2 (ng/L)	700 (ng/L) ***
Heptachlor Epoxide (ng/L)	R T													1 (ng/L)	3000 (ng/L) +++
Heptachlor (ng/L)	R T													1 (ng/L)	3000 (ng/L) +++
Hexachlorobenzene (ng/L)	R T													1 (ng/L)	10 (ng/L) h
Hexachlorobutadiene (ug/L)	R T														
Hexachloroethane (ng/L)	R T													1 (ng/L)	19000 (ng/L) e
Lindane (ng/L)	R T													1 (ng/L)	4000 (ng/L)
Methoxychlor (ng/L)	R T													5 (ng/L)	100000 (ng/L)
Mirex (ng/L)	R T													5 (ng/L)	

ORGANOCHLORINES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Octachlorostyrene (ng/L)	R T													1 (ng/L)	
O,P-DDT (ng/L)	R T													5 (ng/L)	30000 (ng/L) d
Oxychlordane (ng/L)	R T													2 (ng/L)	
PCB Total (ng/L)	R T													20 (ng/L)	3000 (ng/L) t
Pentachlorobenzene (ng/L)	R T													1 (ng/L)	74000 (ng/L) e
P,P-DDD (ng/L)	R T													5 (ng/L)	d
P,P-DDE (ng/L)	R T													1 (ng/L)	d
P,P-DDT (ng/L)	R T													5 (ng/L)	d
1,2,3,4-Tetra-chlorobenzene (ng/L)	R T													1 (ng/L)	
1,2,3,5-Tetra-chlorobenzene (ng/L)	R T													1 (ng/L)	

ORGANOCHLORINES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]	
1,2,4,5-Tetra-chlorobenzene (ng/L)	R T													1 (ng/L)	38000 (ng/L)	e
Thiodan I (ng/L)	R T													2 (ng/L)	74000 (ng/L)	ea
Thiodan II (ng/L)	R T													4 (ng/L)	74000 (ng/L)	ea
Thiodan Sulphate (ng/L)	R T													4 (ng/L)		
Toxaphene (no units available)	R T															
1,2,3-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L)	y
1,2,4-Trichlorobenzene (ng/L)	R T													5 (ng/L)	15000 (ng/L)	y
1,3,5-Trichlorobenzene (ng/L)	R T													5 (ng/L)	10000 (ng/L)	y
2,3,6-Trichlorotoluene (ng/L)	R T													5 (ng/L)		
2,4,5-Trichlorotoluene (ng/L)	R T													5 (ng/L)	10000 (ng/L)	g

TRIAZINES		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
TRIAZINES															
2,6,A-Trichlorotoluene (ng/L)	R T													5 (ng/L)	
Alachlor (ng/L)	R T														
Ametrine (ng/L)	R T													50 (ng/L)	
Atratone (ng/L)	R T														
Atrazine (ng/L)	R T													50 (ng/L)	46000 (ng/L) !
Bladex (ng/L)	R T													100 (ng/L)	10000 (ng/L) !
Metolachlor (ng/L)	R T														
Prometone (ng/L)	R T													50 (ng/L)	
Prometryne (ng/L)	R T													50 (ng/L)	1000 (ng/L) !
Propazine (ng/L)	R T													50 (ng/L)	

TRIAZINES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ GUIDELINE[1]
Sencor (ng/L)	R T													100 (ng/L)	
Simazine (ng/L)	R T													50 (ng/L)	10000 (ng/L) !
SPECIAL PESTICIDES															
2,4-D (ng/L)	R T													100 (ng/L)	100000 (ng/L)
2,4-D Butyric Acid (ng/L)	R T													200 (ng/L)	18000 (ng/L) !
Dicamba (ng/L)	R T													100 (ng/L)	87000 (ng/L) !
Pentachlorophenol (ng/L)	R T													50 (ng/L)	10000 (ng/L) h
Picloram (ng/L)	R T													100 (ng/L)	
2,4-D Propionic Acid (ng/L)	R T													100 (ng/L)	
Silvex (ng/L)	R T													50 (ng/L)	10000 (ng/L)
2,4,5-T (ng/L)	R T													50 (ng/L)	

SPECIAL PESTICIDES (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
2,3,4,5-Tetra-chlorophenol (ng/L)	R T													50 (ng/L)	
2,3,5,6-Tetra-chlorophenol (ng/L)	R T													50 (ng/L)	
2,3,4-Trichlorophenol (ng/L)	R T													100 (ng/L)	
2,4,5-Trichlorophenol (ng/L)	R T													50 (ng/L)	
2,4,6-Trichlorophenol (ng/L)	R T													50 (ng/L)	10000 (ng/L) h
ORGANOPHOSPHOROUS PEST'S.															
Diazinon (ng/L)	R T													50 (ng/L)	14000 (ng/L)
Dichlorovos (ng/L)	R T													10 (ng/L)	
Dursban (ng/L)	R T													10 (ng/L)	
Ethion (ng/L)	R T													10 (ng/L)	
Guthion (ng/L)	R T													1000 (ng/L)	

ORGANOPHOSPHOROUS PEST'S. (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Malathion (ng/L)	R T													10.0 (ng/L)	
Methylparathion (ng/L)	R T													50 (ng/L)	7000 (ng/L)
Methyltrithion (ng/L)	R T													100 (ng/L)	
Mevinphos (ng/L)	R T													10 (ng/L)	
Parathion (ng/L)	R T													50 (ng/L)	35000 (ng/L)
Phorbate (ng/L)	R T													10 (ng/L)	
Reldan (ng/L)	R T													10 (ng/L)	
Ronnel (ng/L)	R T													10 (mg/L)	
MASS SPEC.															
Di-N-Butyl Phthalate (ug/L)	R T													0.1 (ug/L)	34000 (ug/L) e

MASS SPEC. (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
N-Dichloromethylene-Pentachloroanaline (ug/L)	R T													0.1 (ug/L)	
Diphenyl Ether (ug/L)	R T													0.1 (ug/L)	
Fluoranthene (ug/L)	R T													0.1 (ug/L)	
Hexachloropropene (ug/L)	R T													0.1 (ug/L)	
Methyl Phenanthrene (ug/L)	R T													0.1 (ug/L)	
Naphthalene (ug/L)	R T													0.1 (ug/L)	
Pentachlorobutadiene (ug/L)	R T													0.1 (ug/L)	
Pentachloropropane (ug/L)	R T													0.1 (ug/L)	
Pentachloropropene (ug/L)	R T													0.1 (ug/L)	
Pyrene (ug/L)	R T													0.1 (ug/L)	

MASS SPEC. (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Tetrachlorbutane (ug/L)	R T													0.1 (ug/L)	
Tetrachlorobiphenyl (ug/L)	R T													0.1 (ug/L)	
BACTERIA															
Raw Water:															
Total Coliform MF	R	252	453	315	145	17	8	75	200	56	197	585	660		
Total Coliform BKGD	R													0	
Fecal Coliform MF (count/100 mL)	R	7	45	16	4	1	3	0	24	10	21	25	22	0	0/0.1 (mL)
Standard Plate Count MF (count/mL)	R														500
Treated Water:															
Present/Absent Test	T														
Total Coliform Background MF (count/100 mL)	T	0	0	0	0	0	0	0	0	0	0	0	0	0	OWDO Bacti
Fecal Coliform MF (count/100 mL)	T													0	OWDO Bacti

BACTERIA (cont'd.)		1985 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DWSP DETECTION LIMIT	DRINKING WATER OBJ. GUIDELINE[1]
Treated Water (cont'd.)															
Standard Plate Count MF (count/100 mL)	T														
If Present/Absent Test Positive:															
Coliform P/A	R T														
Fecal Coliform P/A	R T														
E. Coli P/A	R T														
Aromonas P/A	R T														
Staph. Aureus P/A	R T														
P/A Bottle	T														

TABLE 5.1 - FOOTNOTES

l	= see individual footnotes for agency of guideline origin
c	= California State Department of Health action level
d	= OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e	= USEPA ambient guideline
ea	= United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep	= USEPA proposed maximum contaminant level for drinking water
g	= suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h	= World Health Organization (WHO) guideline
h*	= World Health Organization (WHO) odour threshold
mg/L	= milligrams per litre, parts per million (ppm)
ng/L	= nanograms per litre, parts per trillion (ppt)
Presence/Absence	= microbiological test to indicate presence or absence of coliform bacteria
R	= raw water
T	= treated drinking water
t	= ODWO interim maximum acceptable concentration (IMAC)
ug/L	= micrograms per litre, parts per billon (ppb)
y	= New York State (taste and odour) proposed drinking water guideline
++	= total trihalomethanes
+++	= combined total: heptachlor and heptachlor epoxide
*	= if other than DWSP detection limit
**	= total of aldrin and dieldrin
***	= chlordane is a mixture of alpha and gamma isomers
!	= Ministry of the Environment and Health and Welfare Canada (IMAC)
-	= No quantifiable results. This includes readings that are non-detectable and readings that are detected but not quantifiable.
G	= ODWO suggested guideline

TABLE 6.0: ALGAE COUNT

WPOS - BELLEVILLE WTP

		1986	1985	1984	1983
JAN	Max.				
	Min.				
	Avg.				
	No. Tests				
FEB	Max.				
	Min.				
	Avg.				
	No. Tests				
MAR	Max.				3831
	Min.				787
	Avg.				2068
	No. Tests				6
APR	Max.	5251	6681	2618	2262
	Min.	4126	915	628	809
	Avg.	4688	2959	1887	1435
	No. Tests	2	10	3	6
MAY	Max.	6605	6314	7300	6606
	Min.	3779	718	1214	2363
	Avg.	5355	3129	3919	4212
	No. Tests	4	17	12	12
JUN	Max.	4544	6982	7648	4098
	Min.	337	1043	968	65
	Avg.	2082	3628	3484	1328
	No. Tests	7	14	21	16

		1986	1985	1984	1983
JUL	Max.	6301	17718	12179	8121
	Min.	1134	2818	4860	2833
	Avg.	3203	6865	7638	4634
	No. Tests	10	19	9	6
AUG	Max.	13490	13839	12157	9237
	Min.	3185	4176	5750	1376
	Avg.	9090	9383	7861	5148
	No. Tests	9	18	14	17
SEP	Max.	11316	11402	14016	10402
	Min.	2017	5435	4620	7498
	Avg.	4782	8735	8037	8834
	No. Tests	8	9	13	12
OCT	Max.	2305	8469	8440	10390
	Min.	1293	4472	3505	5150
	Avg.	1746	6743	5419	6899
	No. Tests	3	3	14	
NOV	Max.		3321	8481	7156
	Min.		632	2108	1952
	Avg.		2210	3981	3741
	No. Tests		4	10	12
DEC	Max.				1703
	Min.				968
	Avg.				1292
	No. Tests				3

Note: These tests are conducted at the Belleville plant using a standard whipple cell appartus. Units used are ASU - (areal standard units). Blanks indicate no testing performed.

TABLE 7.0: Bacteriological Testing (1986)

WPOS - BELLEVILLE WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	800	240	547	19	11	14						
	T			0									
FEB	R	(Est)860	84	451	110	10	48						
	T			0									
MAR	R	2200	42	719	>150	3	>42						
	T			0									
APR	R	168	16	96	6	0	2						
	T			0									
MAY	R	400	32	177	23	1	8						
	T			0									
JUN	R	1000	2	276	4	2	3						
	T			0									
JUL	R	2200	(Est)24	< 706	6	0	2						
	T			0									
AUG	R	< 100	(Est)7	< 69	7	0	2						
	T			0									
SEP	R	1200	16	419	(Est)130	3	(Est)38						
	T			0									
OCT	R												
	T												
NOV	R												
	T												
DEC	R												
	T												

Legend

EST = Estimated < = Less than > = Greater than

WPOS - BELLEVILLE WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	420	156	252	(Est)10	5	(Est)7						
	T			0									
FEB	R	A900	220	453	83	24	45						
	T			0									
MAR	R	600	200	(Est)315	25	5	16						
	T			0									
APR	R	200	56	145	7	2	4						
	T			0									
MAY	R	32	4	17	2	0	1						
	T			0									
JUN	R	(Est)16	(Est)8	(Est)8	4	3	3						
	T			0									
JUL	R	100	2	< 75	1	0	0						
	T			0									
AUG	R	A200	A200	A200	39	3	24						
	T			0									
SEP	R	(Est)100	10	< 56	30	1	10						
	T			0									
OCT	R	500	32	197	54	5	21						
	T			0									
NOV	R	1600	42	585	41	11	25						
	T			0									
DEC	R	1100	280	660	25	17	22						
	T			0									

Legend

EST = Estimated A = Approximate < = Less than

TABLE 7.2: Bacteriological Testing (1984)

WPOS - BELLEVILLE WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	(Est)338	36	147	>150	2	>39						
	T			0									
FEB	R	2400	14	649	32	2	12						
	T			0									
MAR	R	1200	(Est)260	(Est)725	48	21	35						
	T			0									
APR	R	108	38	73	8	2	5						
	T			0									
MAY	R	1900	<2	396	3	0	<2						
	T			0									
JUN	R	(Est)40	2	(Est)19	9	0	4						
	T			0									
JUL	R	A300	(Est)2	(Est)78	4	0	1						
	T			0									
AUG	R	1100	(Est)68	(Est)442	19	3	9						
	T			0									
SEP	R	(Est)160	(Est)160	(Est)160	130	8	69						
	T			0									
OCT	R	(Est)40	6	(Est)20	37	4	12						
	T			0									
NOV	R	12000	0	3036	16	9	12						
	T			0									
DEC	R	62	20	35	9	3	5						
	T			0									

Legend

EST = Estimated A = Approximate < = Less than > = Greater than

WPOS - BELLEVILLE WTP

		TOTAL COLIFORM			FECAL COLIFORM			FECAL STREP			AEROMONAS/PSEUDO AEROG/OTHERS		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	R	5600	62	1540	90	11	47						
	T			0									
FEB	R	>4300	60	>1184	150	6	53						
	T			0									
MAR	R	40	2	19	7	1	2						
	T			0									
APR	R	A800	12	A258	7	A2	A3						
	T			0									
MAY	R	(Est)560	88	(Est)206	150	A1	A37						
	T			0									
JUN	R	2300	28	1164	3	0	2						
	T			0									
JUL	R	>15000	36	>5379	150	0	38						
	T			0									
AUG	R	(Est)700	(Est)10	(Est)276	33	A2	A10						
	T			0									
SEP	R	140	3	71	13	3	8						
	T			0									
OCT	R	-	-	-	-	-	-						
	T			0									
NOV	R	102	56	83	28	2	10						
	T			0									
DEC	R	5100	58	2253	520	14	228						
	T			0									

Legend

- = Sampled but not analyzed
Est = Estimated values
A = Prefix indicates approximate
> = Greater than

TABLE 8.0: ALERT LEVELS
(TREATED WATER AT PLANT)

WPOS - BELLEVILLE WTP

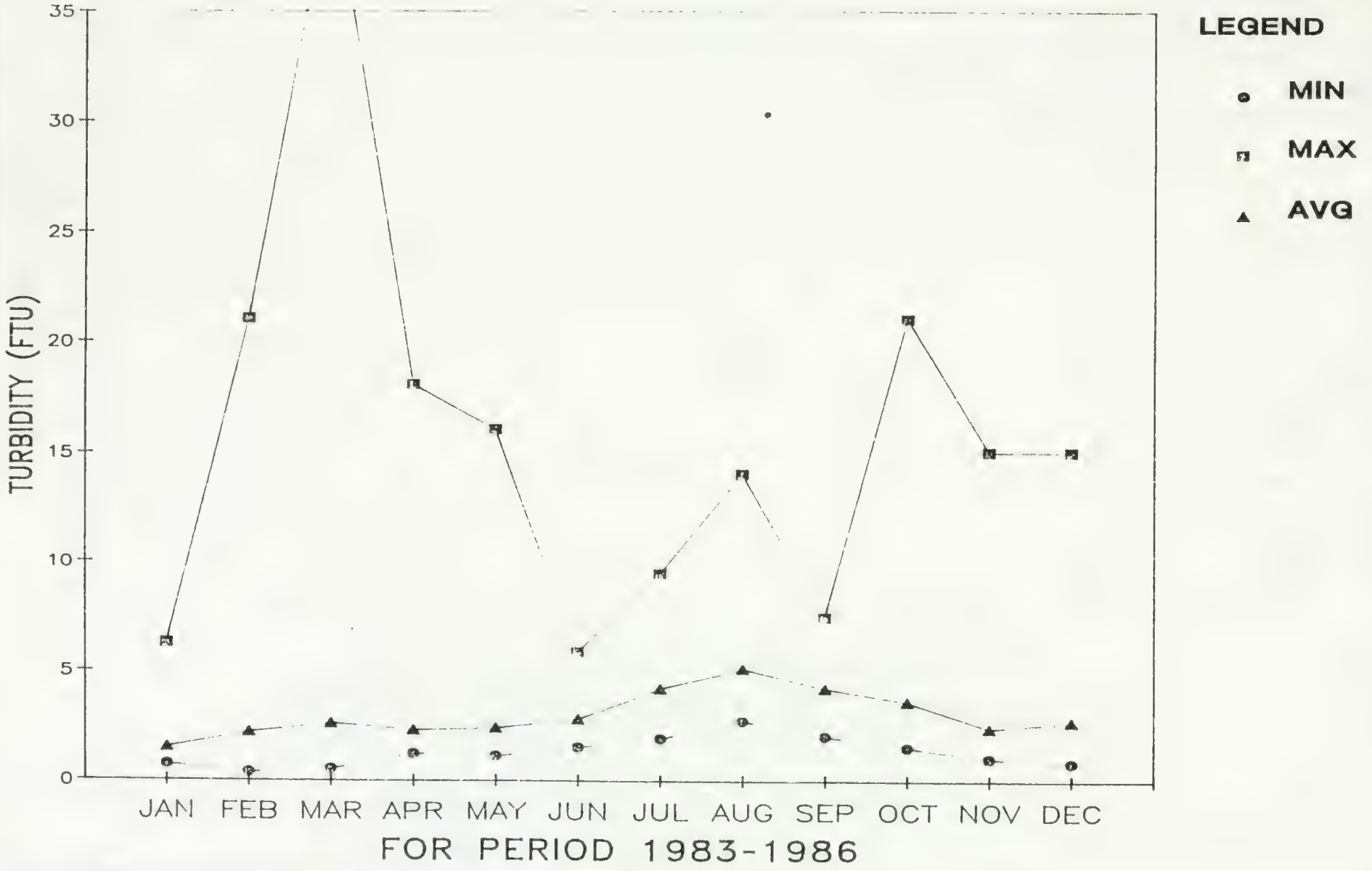
DATE	PARAMETER	MEASURED PARAMETER	GUIDELINE LIMIT
Mar. 5/85	Colour	6 TCU	5 TCU
Apr. 2/85	Colour	7 TCU	5 TCU
Jul. 2/85	Colour	9 TCU	5 TCU
Apr.30/85	Manganese	3.5 mg/L	0.05 mg/L

APPENDIX B
GRAPHICAL TURBIDITY DATA

BELLEVILLE WTP

FIG. 1: COMPOSITE PROFILE

RAW WATER TURBIDITY RANGES



FOR PERIOD 1983-1986

BELLEVILLE WTP

FIG.2: COMPOSITE PROFILE

TREATED WATER TURBIDITY RANGES

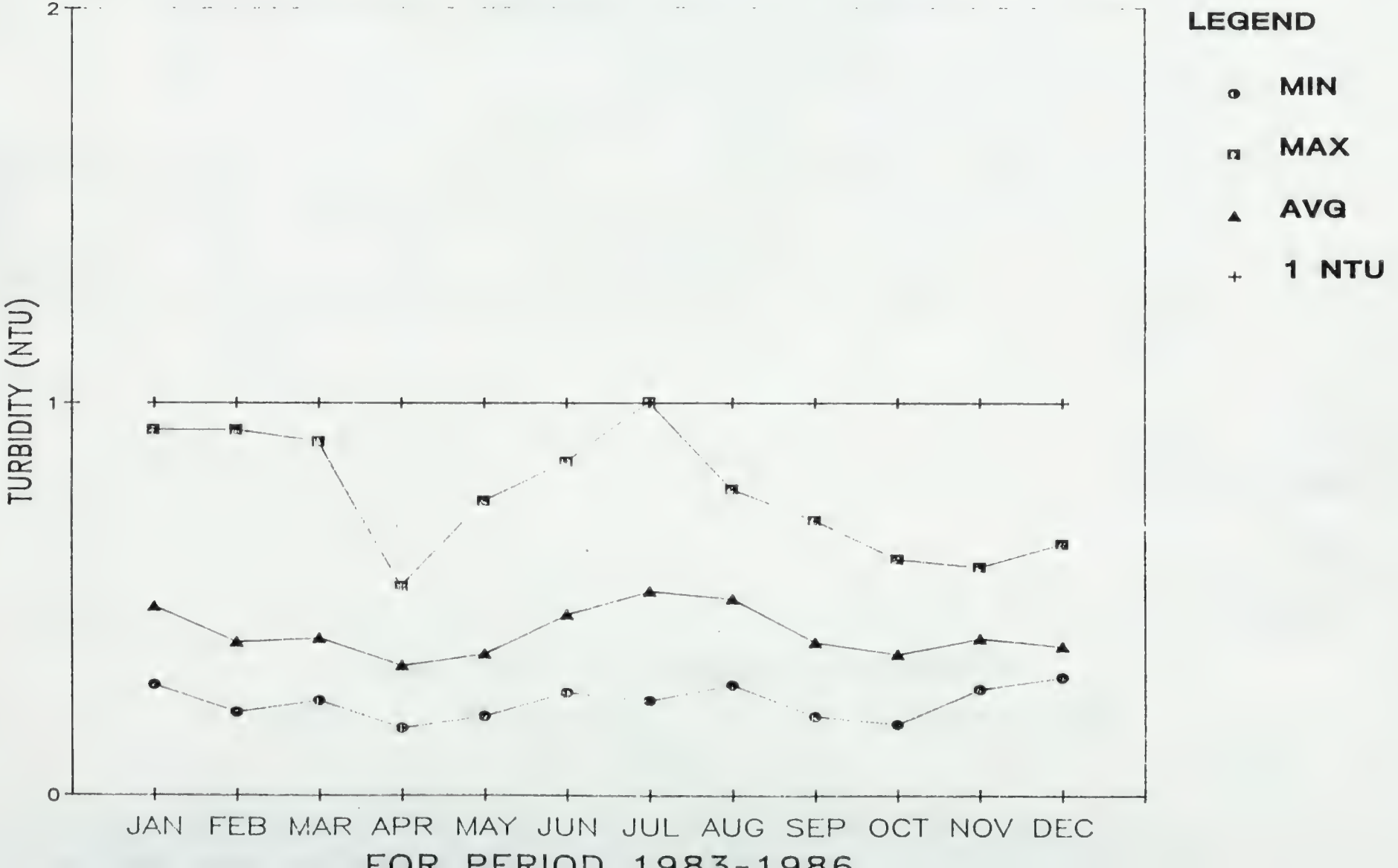


FIG.3: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

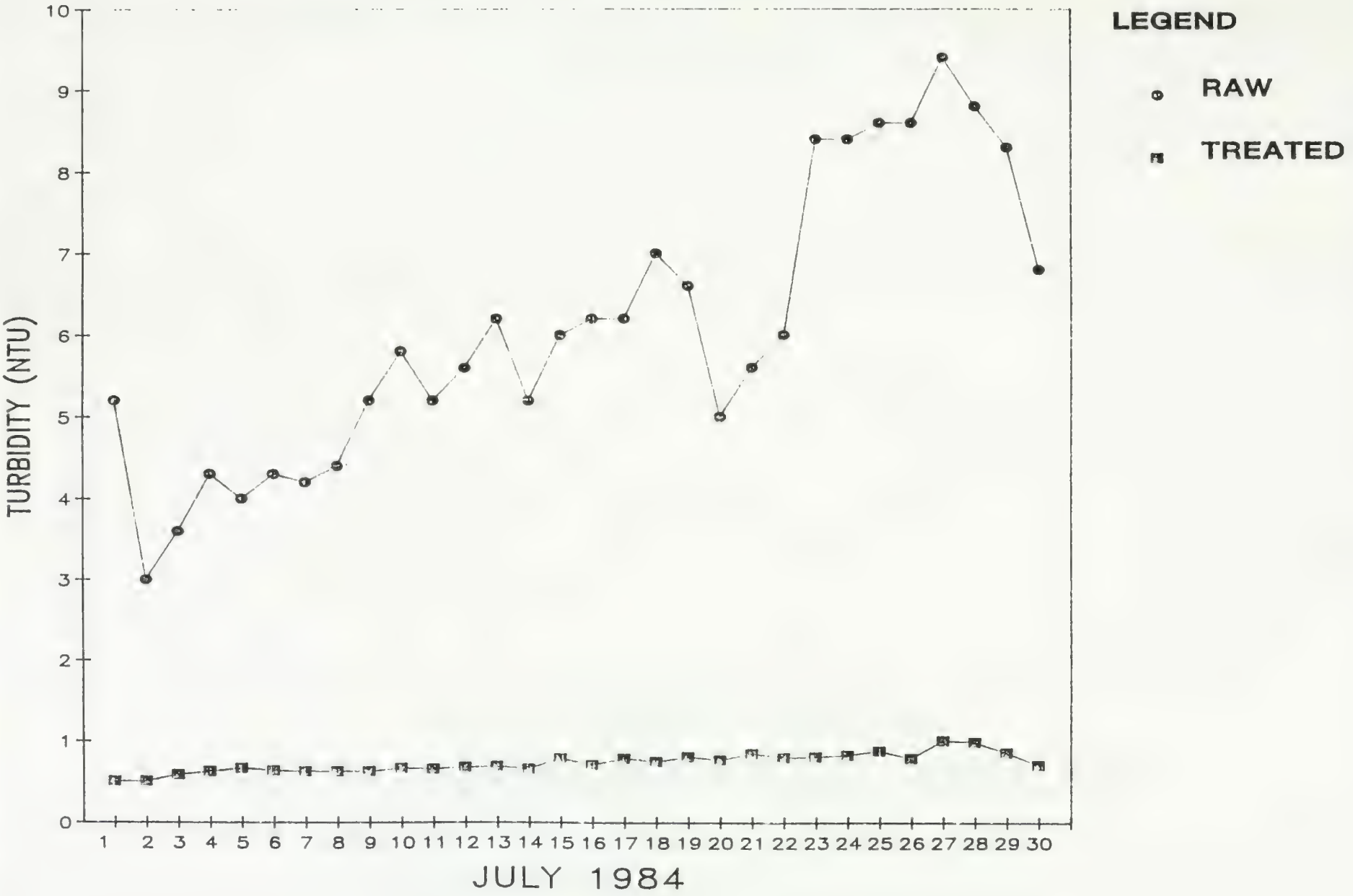


FIG.4: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

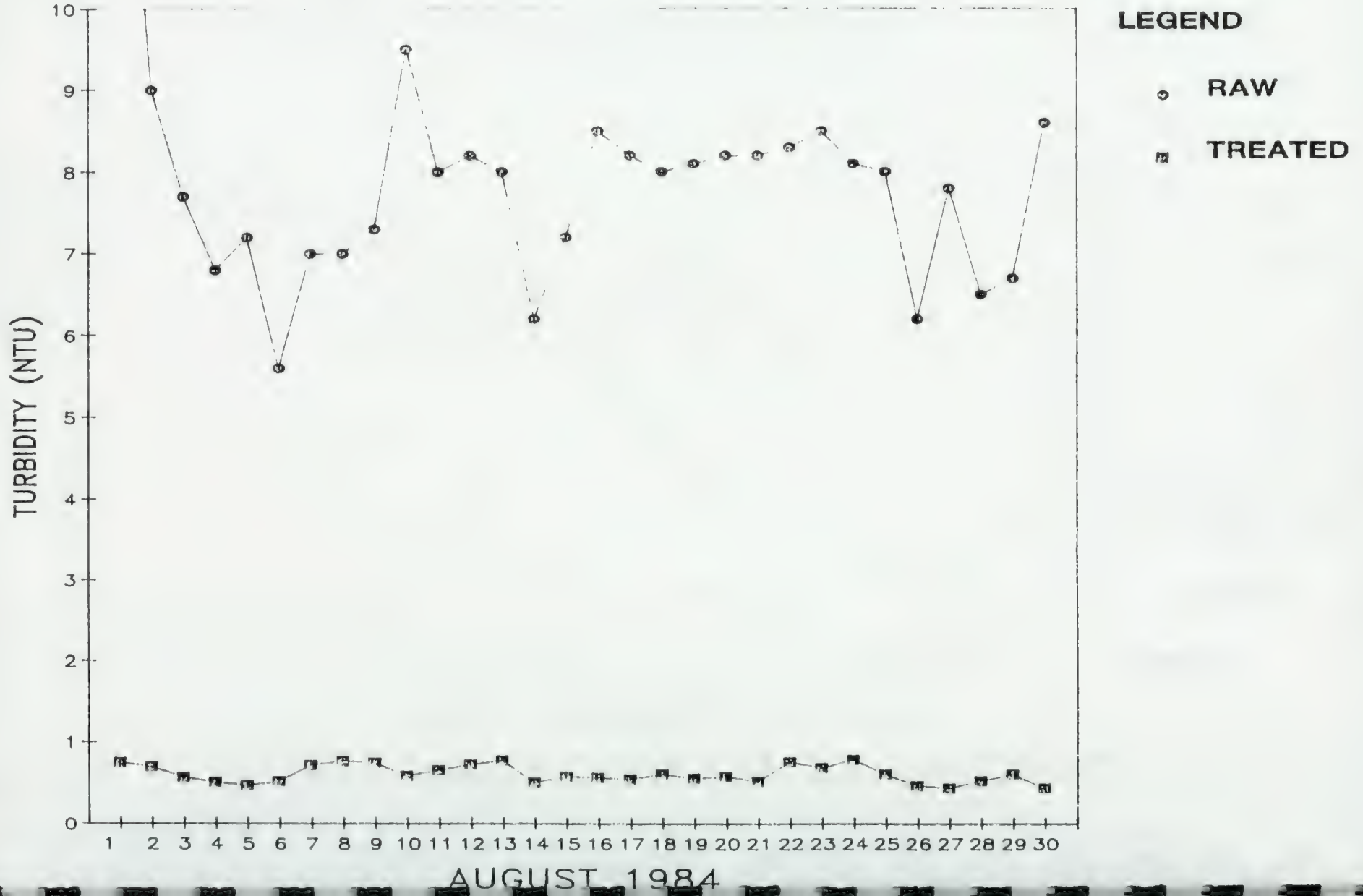


FIG.5: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

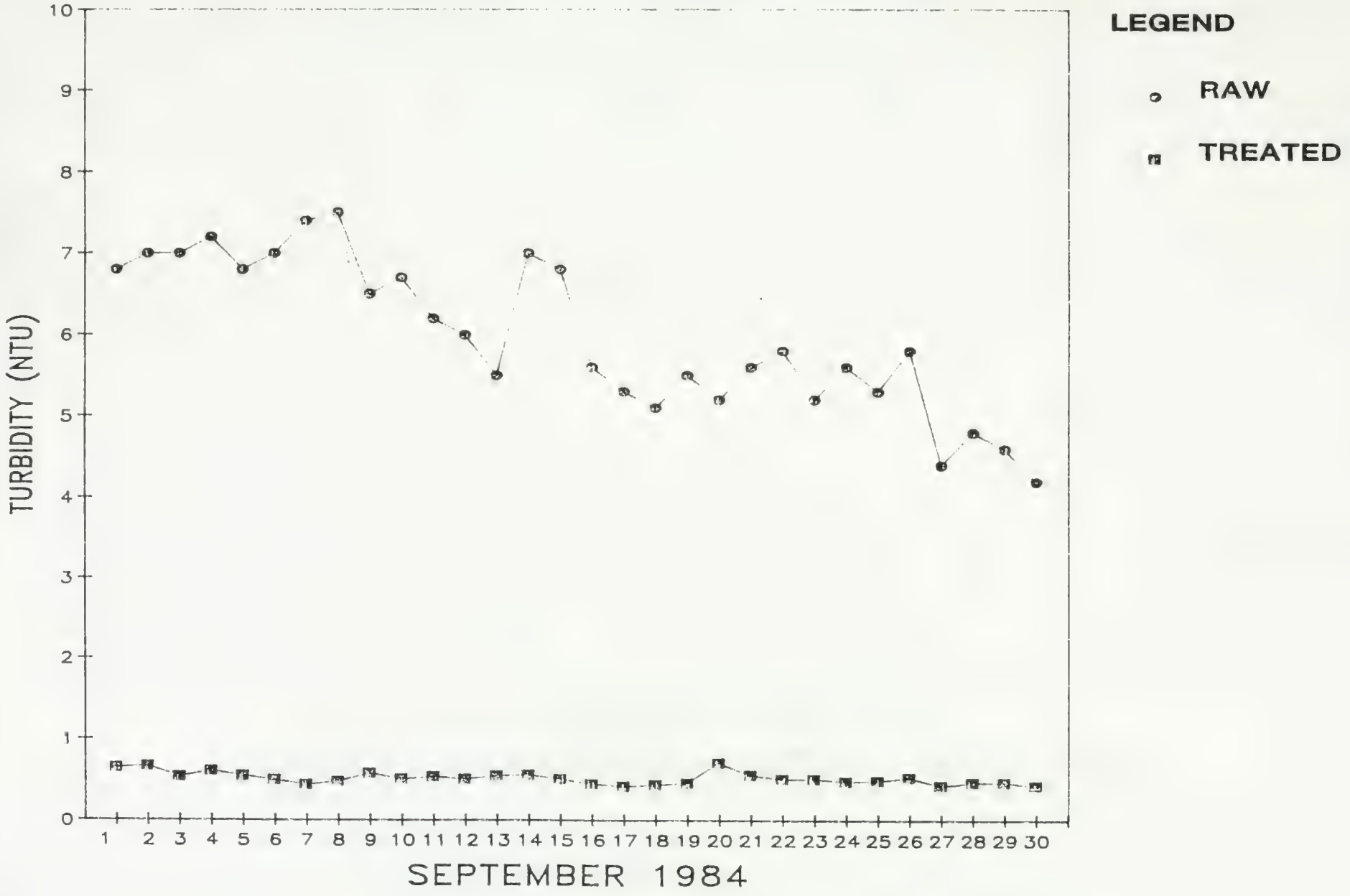


FIG.6: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

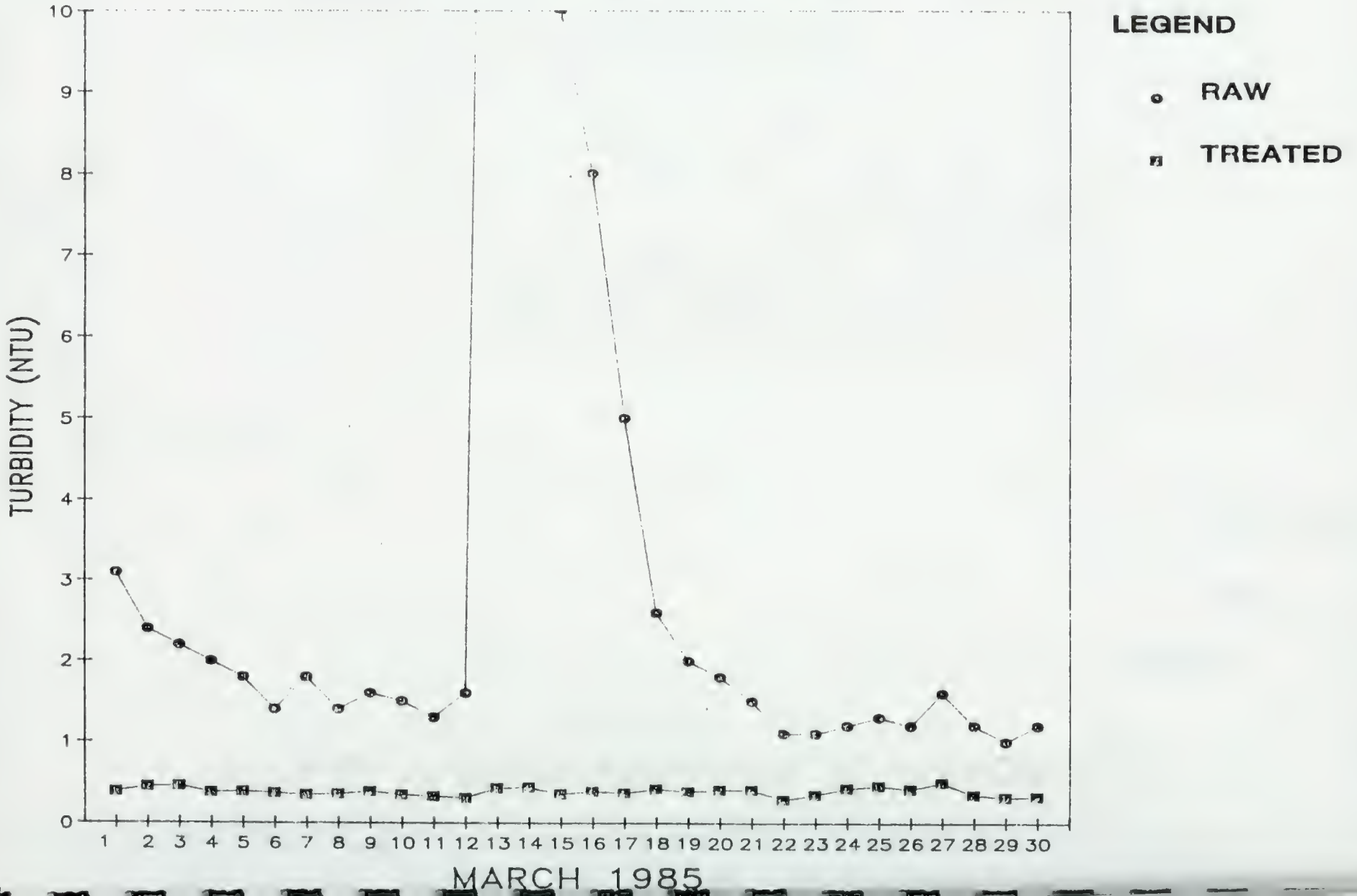


FIG.7: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

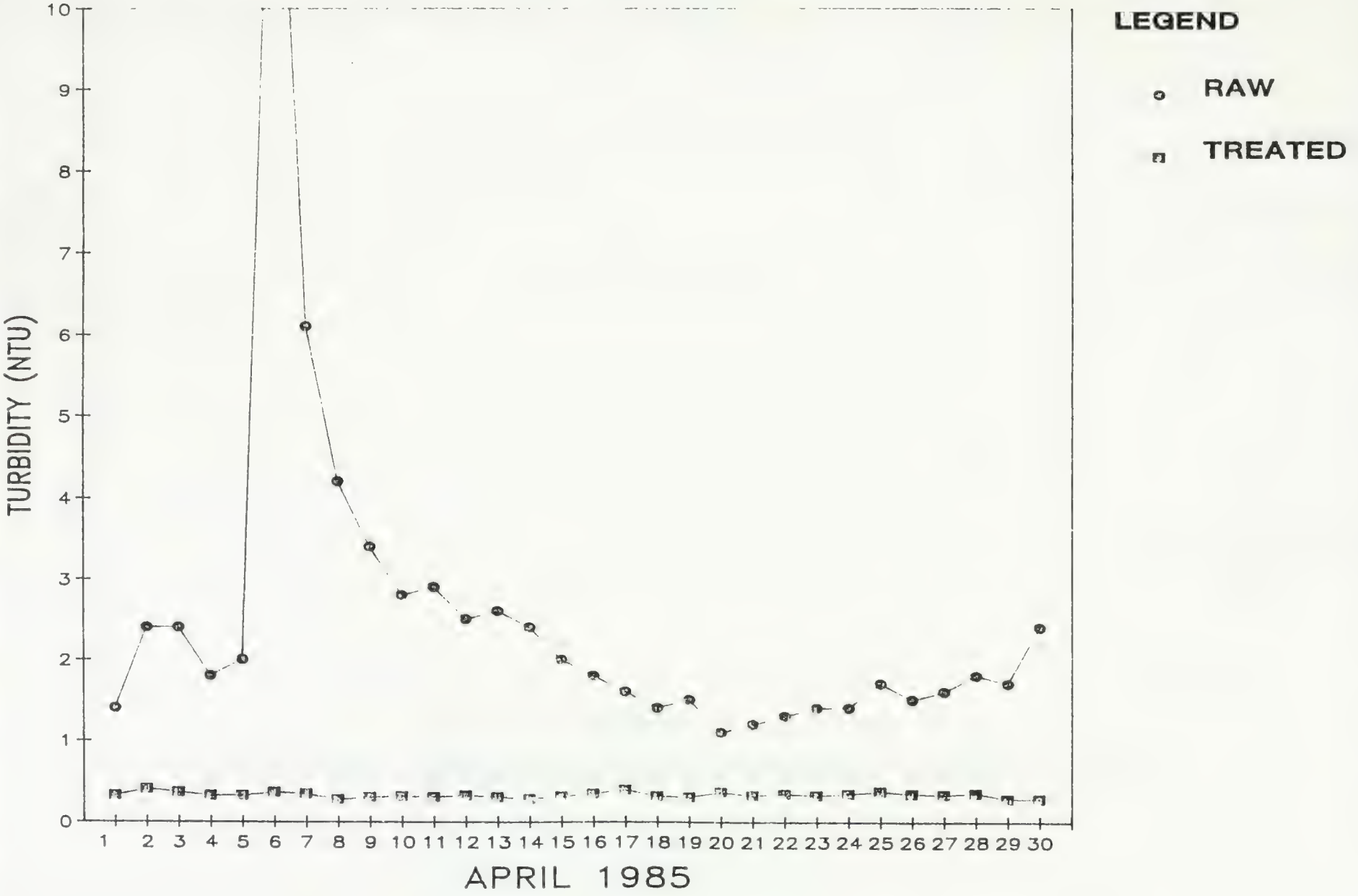


FIG.8: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

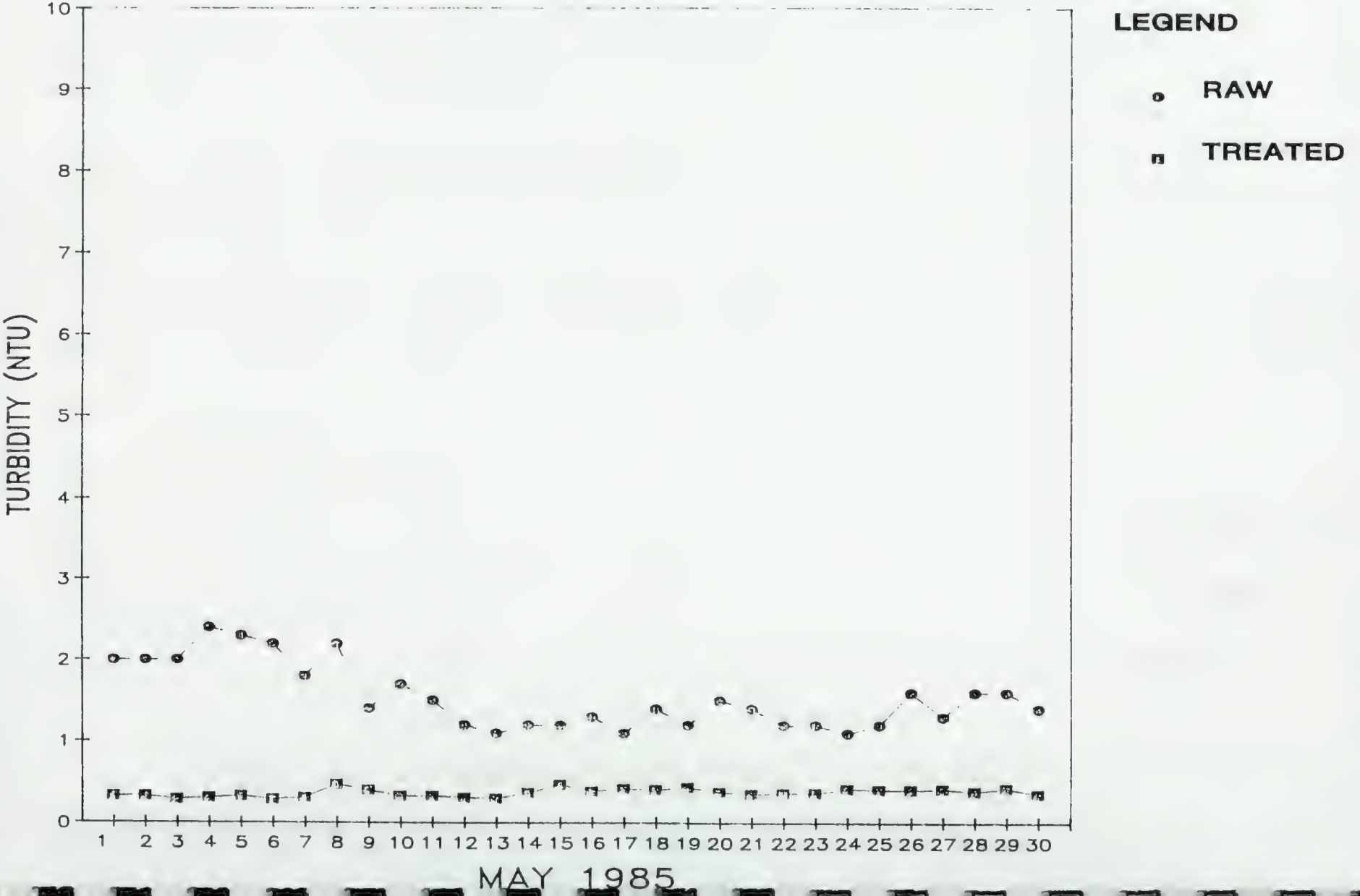


FIG.9: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

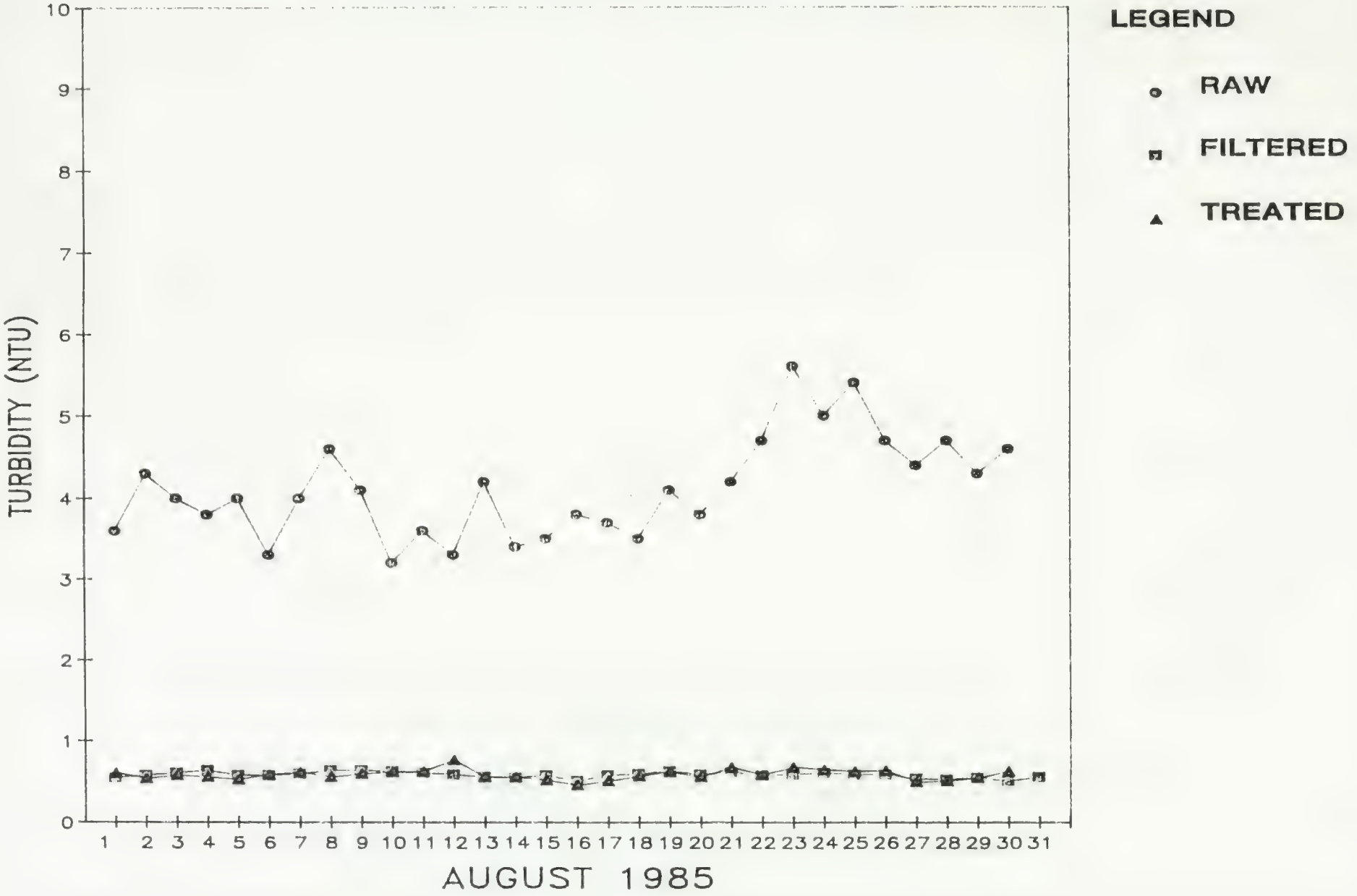


FIG. 10: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

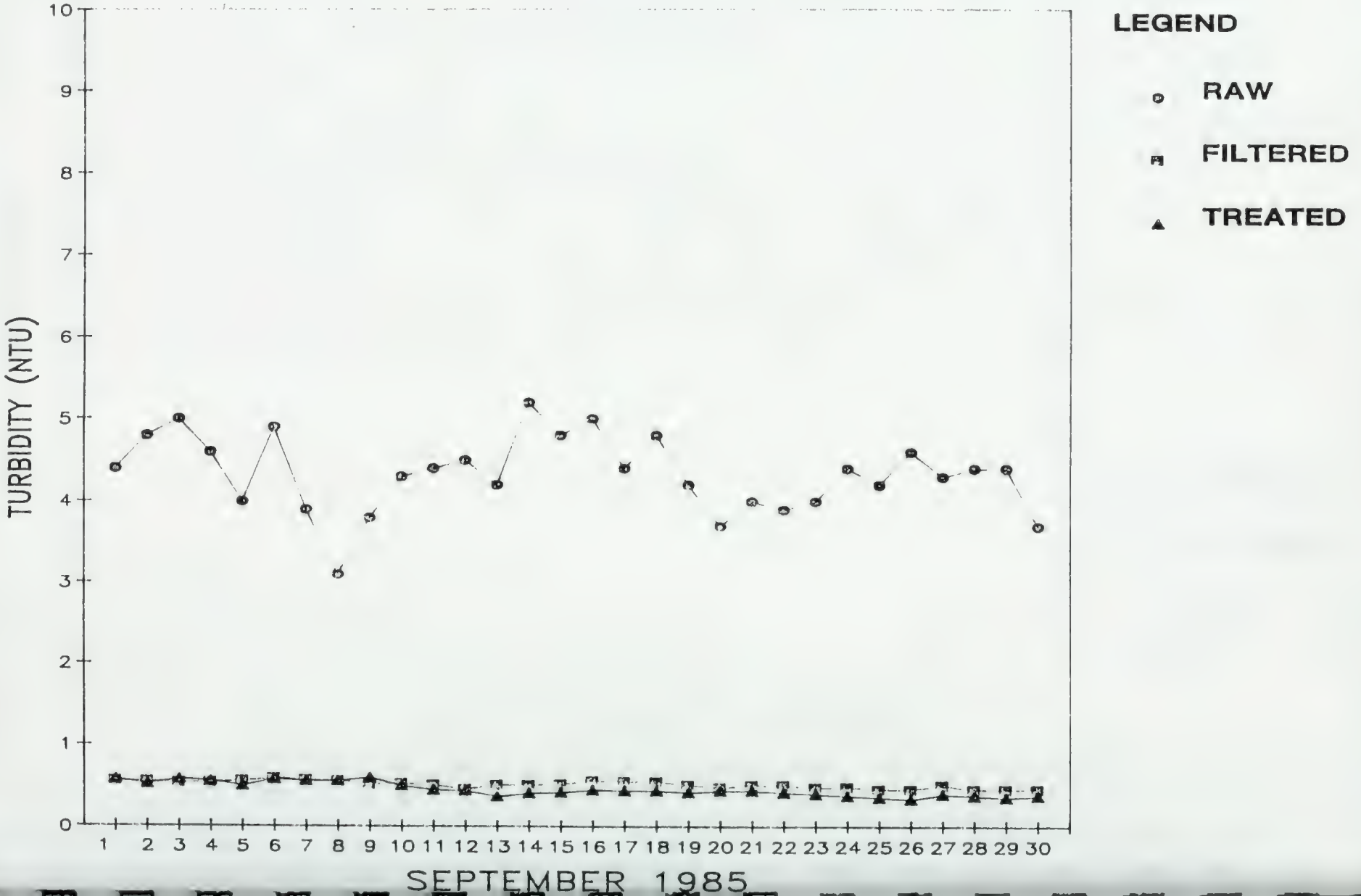


FIG. 11: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

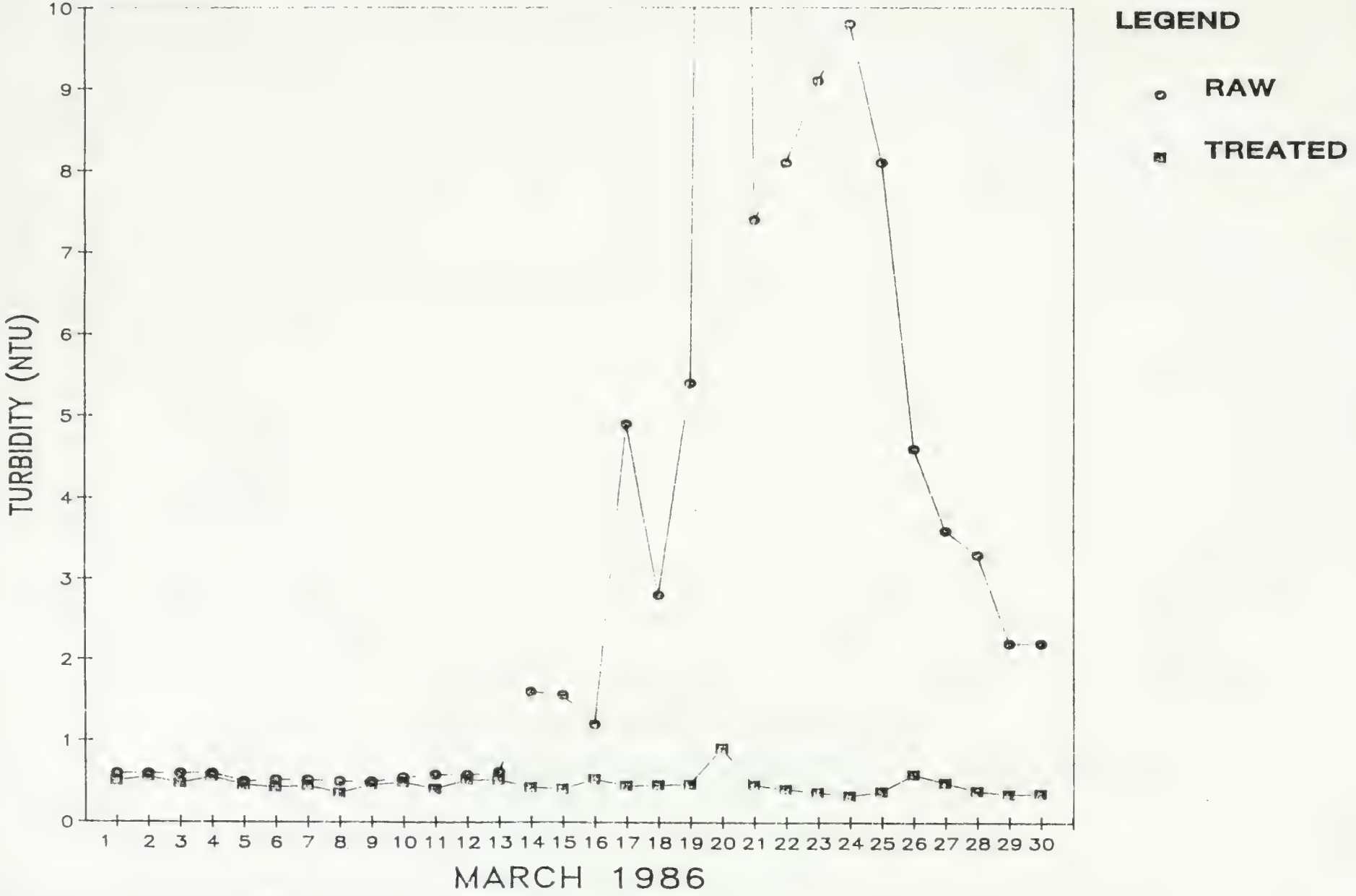


FIG. 12: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS

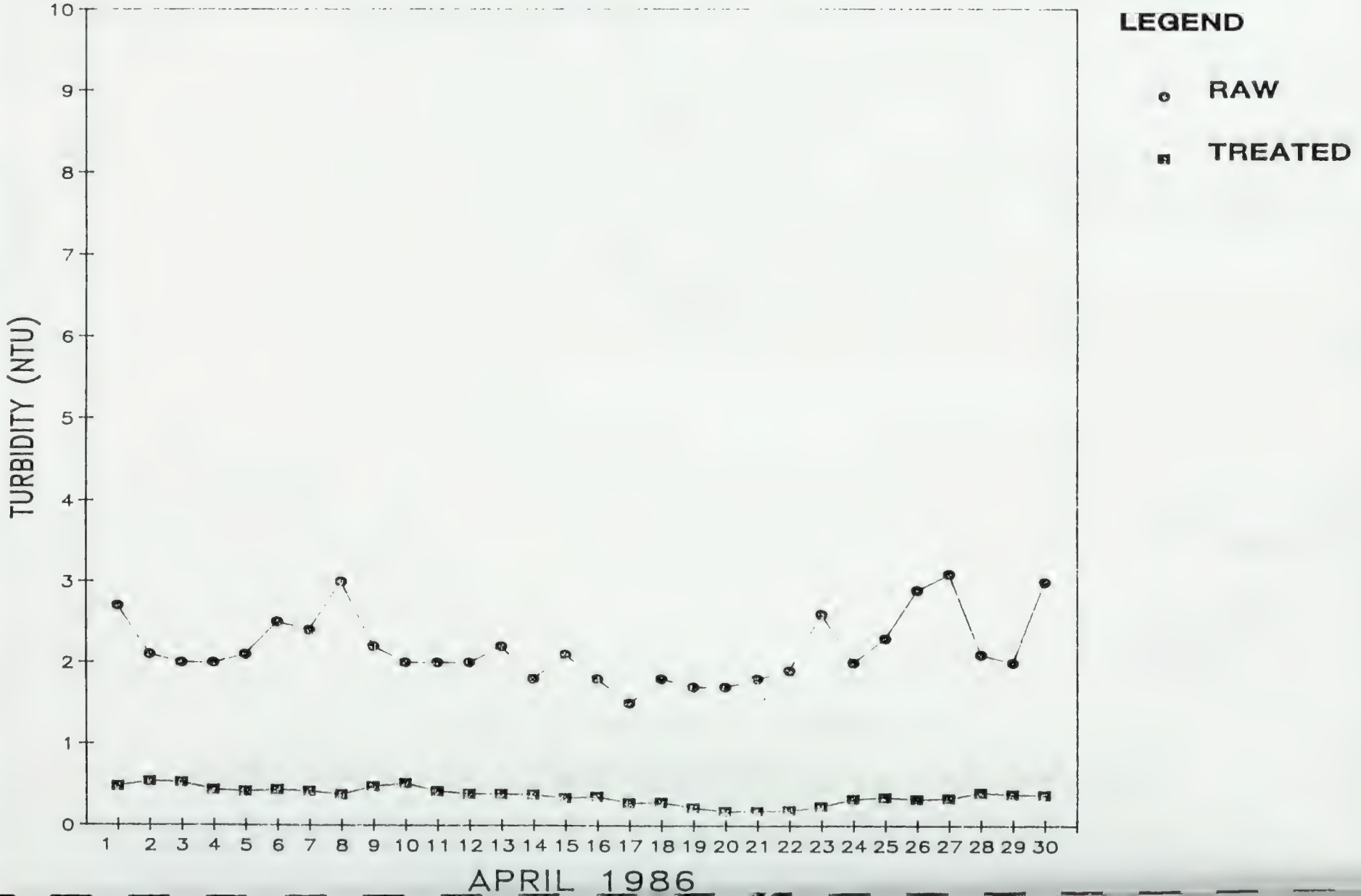
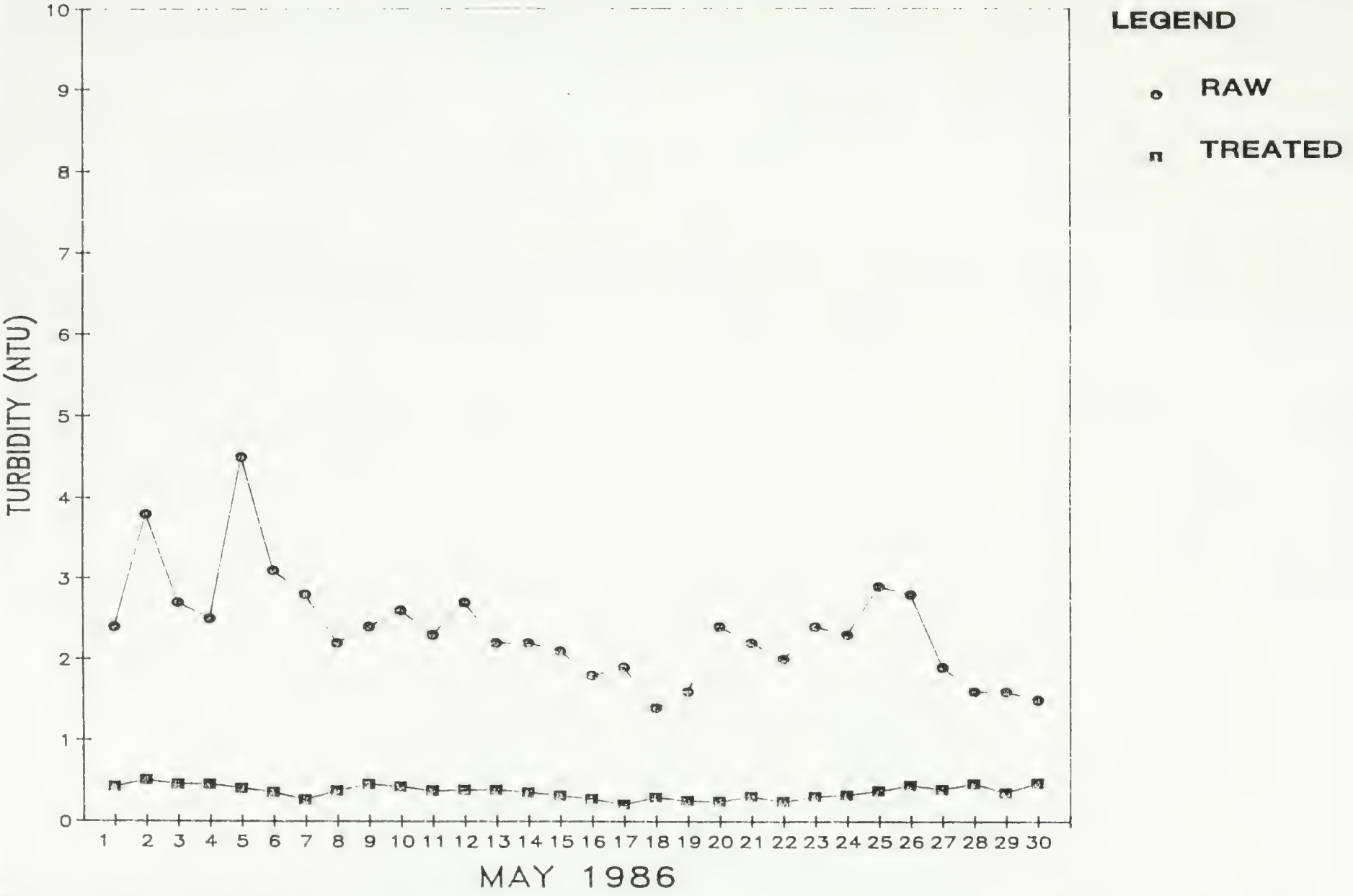


FIG. 13: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS



APPENDIX C
JAR TESTING

BELLEVILLE WTP

Jar Test Procedure

The MSTS test procedure which was used for all testing carried out on Belleville raw water was as follows:

1. 200 ml sample.

2. Two minutes fast mix.

3. Thirty minutes flocculation mixing.

4. Thirty minutes settling time.

5. Filtration through pre-filter, followed by 1.2 µm filter.

The MSTS test procedure is a technique developed by Gore & Storrie Limited which has been shown to provide overall results similar to full scale conventional plant operations consisting of coagulation, flocculation, sedimentation and dual media filtration.

LABORATORY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
18 Sept/86	MOE Water Plant Optimization Study - Belleville WTP	380.62

SAMPLE NO. & DESCRIPTION

Belleville Raw Water:

No. 1 - Typical raw water sample

No. 2 - High turbidity raw water sample

PARAMETERS	SAMPLE NO. 1	SAMPLE NO. 2	SAMPLE NO.	SAMPLE NO.
pH	7.8	7.6		
Colour (TCU)	20	50		
Turbidity (NTU)	4.0	12.5		
Alkalinity (mg/L as $CaCO_3$)	102	104		
Hardness (mg/L as $CaCO_3$)	116	119		
Iron (mg/L)	0.14			
Manganese (mg/L)	0.04			

COMMENTS

CONDUCTED BY	REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
18 Sept/86	MOE Water Plant Optimization Study - Belleville WTP	380.62

TEST DESCRIPTION

Removal of Turbidity with Alum - Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	Alum			pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	20		3	7.65	0.275	<5	90	115	
2	25		3	7.6	0.275	<5	84	112	
3	30		2	7.6	0.250	<5	82	114	
4	35		2	7.4	0.250	<5	80	116	
5	40		1	7.3	0.160	<5	78	113	
6	50		1	7.15	0.200	<5	76	116	
7									
RAW, UNTREATED				7.8	4.0	20	102	116	

SAMPLE TEMPERATURE Start: 10°C Finish: 18°C

COMMENTS

Floc Rating:

1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
25 Oct/86	MOE Water Plant Optimization Study - Belleville WTP	380.62

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 834A Polymer - Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	Alum	834A		pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	0	0		7.60	0.33	5-10			
2	5	0	3	7.60	0.27	5	84	116	
3	5	0.1	3	7.86	0.24	5	90	116	
4	5	0.3	3	8.05	0.24	5	92	115	
5	10	0	2	7.90	0.24	5-10	91	115	
6	10	0.1	1	7.90	0.24	5	90	115	
7	10	0.3	1	7.85	0.24	5	90	114	
RAW, UNTREATED					4.0	20	102	116	

SAMPLE TEMPERATURE Start: 9°C Finish: 18°C

COMMENTS

Floc Rating:

1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
22 Sept/86	MOE Water Plant Optimization Study - Belleville WTP	380.62

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 834A Polymer - Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	Alum	834A		pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	10	0.1	3	7.36	0.20	<5	84	116	
2	10	0.3	3	7.21	0.20	<5	81	115	
3	10	0.5	3	7.53	0.24	<5	90	117	
4	15	0.1	2	7.46	0.175	<5	88	116	
5	15	0.3	1	7.59	0.160	<5	87	116	
6	15	0.5	2	7.43	0.175	<5	86	116	
7									
RAW, UNTREATED				7.8	4.0	20	102	116	

SAMPLE TEMPERATURE Start: 11°C Finish: 18°C

COMMENTS

Floc Rating:

1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
29 Sept/86	MOE Water Plant Optimization Study - Belleville WTP	380.62

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 900N Polymer - Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	Alum	900N		pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	10	0.1	3	7.52	0.275	5-10	84	114	
2	10	0.3	3	7.61	0.250	5-10	86	114	
3	10	0.5	3	7.64	0.25	5-10	85	112	
4	15	0.1	3	7.66	0.20	5	90	113	
5	15	0.3	2	7.70	0.22	5	88	111	
6	15	0.5	2	7.76	0.15	5	87	112	
7									
RAW, UNTREATED				7.8	4.0	20	102	116	

SAMPLE TEMPERATURE Start: 10°C Finish: 18°C

COMMENTS

Floc Rating:

1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
29 Sept/86	MOE Water Plant Optimization Study - Belleville WTP	380.62

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 587C Polymer - Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	Alum	587C		pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	10	0.1	2	7.70	0.34	5-10	90	116	
2	10	0.3	2	7.84	0.35	5-10	92	114	
3	10	0.5	2	7.87	0.33	5-10	94	114	
4	15	0.1	2	7.91	0.35	5	89	114	
5	15	0.3	2	7.85	0.25	5	90	114	
6	15	0.5	2	7.97	0.35	5	93	114	
7									
RAW, UNTREATED				7.8	4.0	20	102	116	

SAMPLE TEMPERATURE Start: 11°C Finish: 18°C

COMMENTS

Floc Rating:

1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
25 Oct/86	MOE Water Plant Optimization Study - Belleville WTP	380.62

TEST DESCRIPTION

Removal of Turbidity with Alum and Magnifloc 834A Polymer - Raw Water Sample No. 2

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	Alum	834A		pH	Turb. (NTU)	Colour (TCU)	Alk. (mg/L)	Hard. (mg/L)	
1	10	0.1	1		0.25	10			
2	10	0.3	1	7.60	0.16	5-10	101	118	
3	10	0.5	1		0.18	5-10			
4	20	0.1	1		0.22	5-10			
5	20	0.3	2		0.25	5-10			
6	20	0.5	2		0.24	5-10			
7									
RAW, UNTREATED					12.5	50			

SAMPLE TEMPERATURE Start: 11°C Finish: 18°C

COMMENTS

Floc Rating:

1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

APPENDIX D

DAILY LOG

BELLEVILLE WATER PURIFICATION AND PUMPING STATION

DAILY OPERATING REPORT

Date

TIME	Chlorine		Well		M.G. Res. 14 ft	Elv. Tank Ft.	Pine Street Res Ft.
	Rate	Resid	C.	R.			
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
16.							
17.							
18.							
19.							
20.							
21.							
22.							
23.							
24.							

MACHINE	EQUIPMENT IN USE												
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	HRS
Pump No. 1													
Pump No. 2													
Pump No. 3													
Pump No. 4													
Transfer. Pump													
L.L. Diesel													
L.L. Pump No. 6													
L.L. Pump No. 7													
H.L. Diesel No. 1													
H.L. Diesel No. 2													
Filter Wash Pump													
Filter Wash Pump													
Alum No. 1													
Alum No. 2													
Chlorine Prech.													
Chlorine Post.													
Fluoride Pump													
Intake Screen													
P.S. No. 1, Elect													
P.S. No. 2, Elect													
P.S. Diesel													
Diesel Gen.													

Chemicals Alum. # 1 Alum # 2 H_2SiF_6

Diesel Fuel W.P.P. Gals. Pine Street Gals.

MICRO STRAINERS							HOURS
	On	Off	On	Off	On	Off	
No. 1							
No 2							
No. 3							
No. 4							

RAW WATER CONDITION

Colour Turbidity Algae

P.H. Temp. R. Well.

FILTERED WATER CONDITION

Colour Turbidity Algae

P.H.

REMARKS

No. Filter Washes Times

Average Filter Run

Time Shut Down

A.G.P.M.

Bar.

Weather Max. Min.

Wind

Rainfall A.M. P.M. TOTAL

Snowfall A.M. P.M. TOTAL

CHEMICALS

Prechlorination	lbs.	
Postchlorination	lbs.	
TOTAL	lbs.	
Aluminum Sulphate	lbs.	
H_2SiF_6	lbs.	

SHIFTS

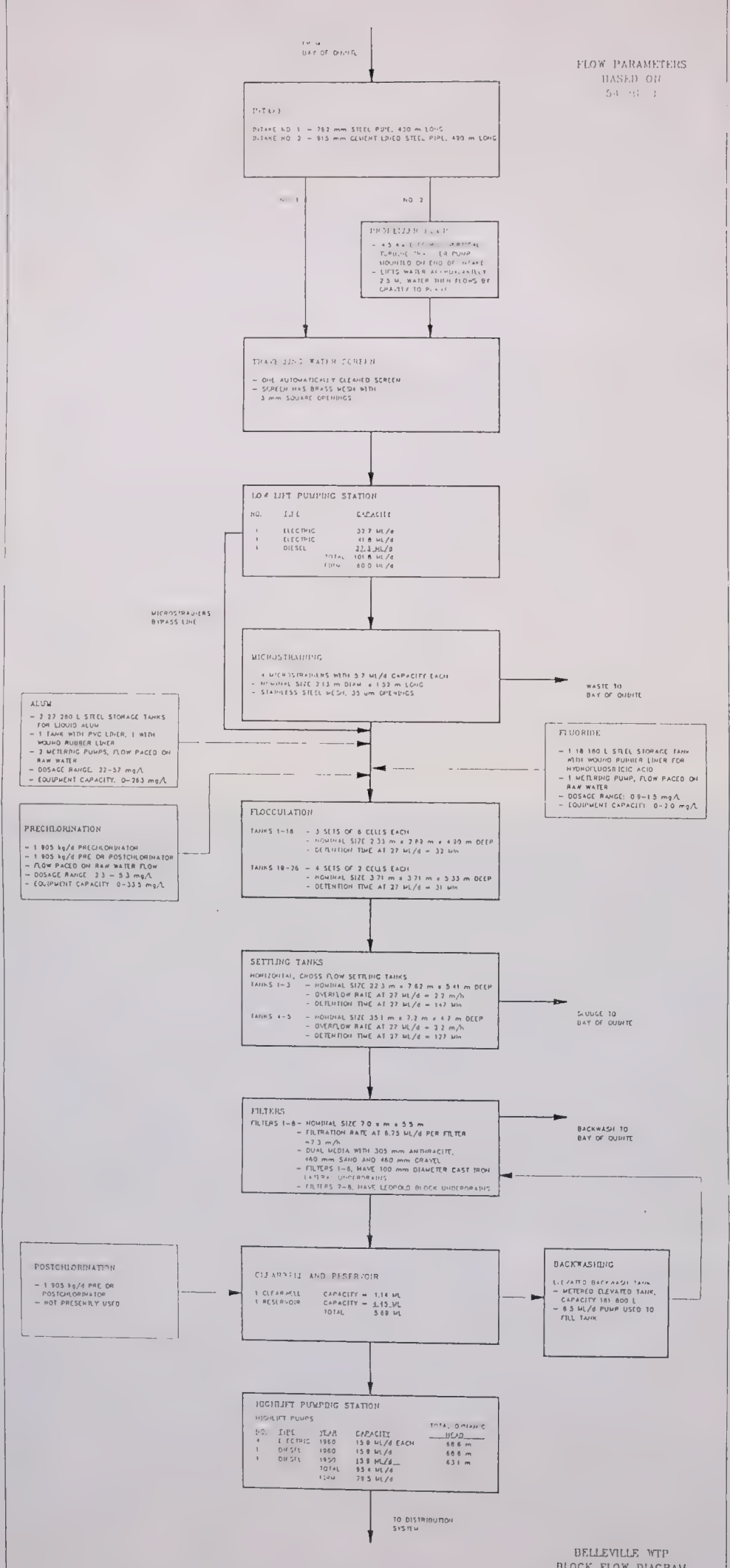
From	To	Operator

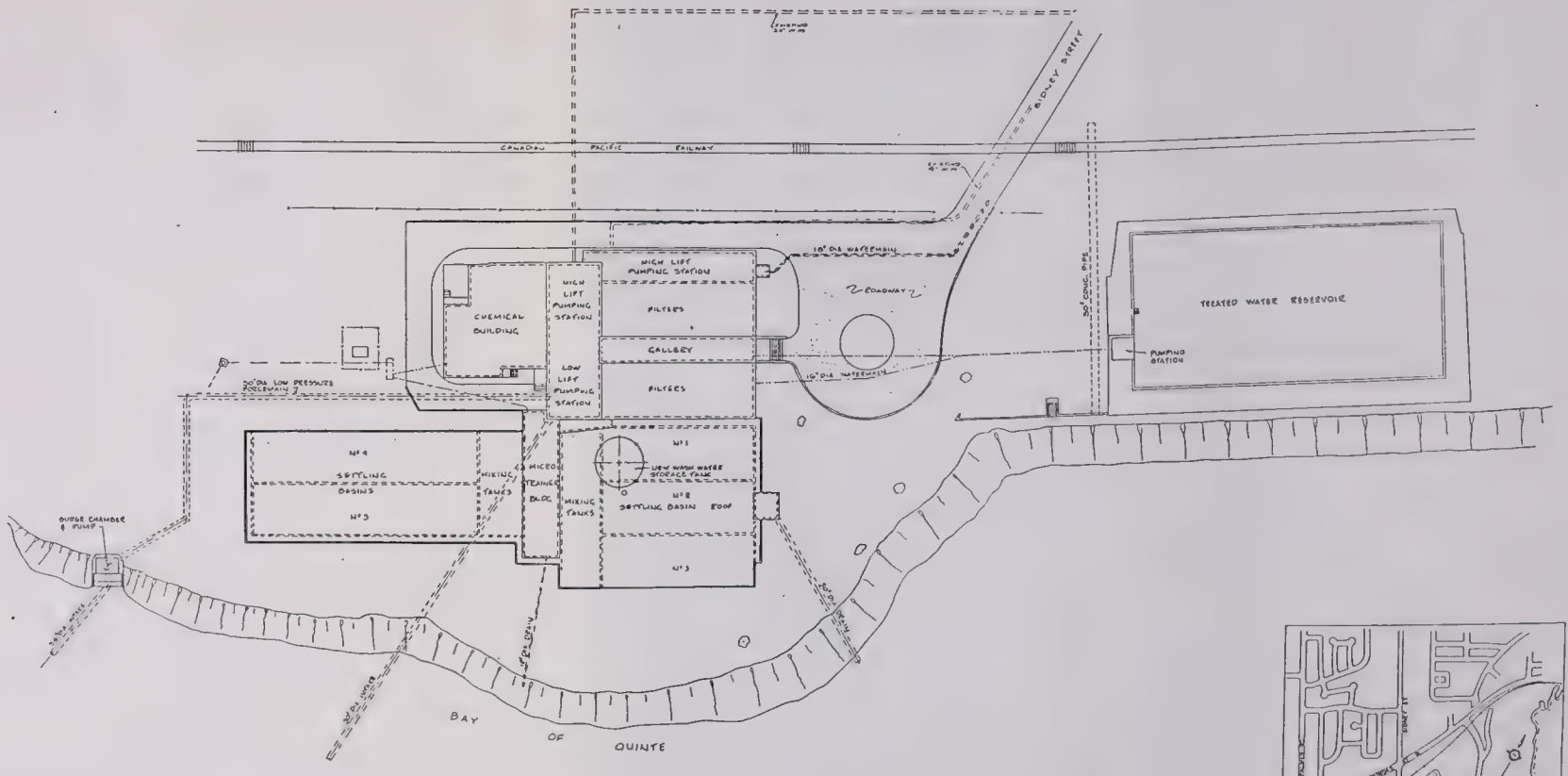
METER	Today	Yesterday	Difference	Total
Venturi No. 1, 16"				
Venturi No. 2, 18"				
Venturi No. 3, 24"				
Raw Water Meter				
Filter Wash Water				
Micro Strainer L.P.				
Micro Strainer H.P.				
Electric Peak				
Electric K.W. Hrs.				
Chemical Feed, 3"				
Surface Wash, 4"				

Rcd.	Out	FIRE ALARMS	LOCATION

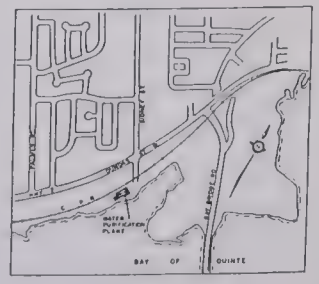
APPENDIX E

DRAWINGS


BAY OF QUINTE
FLOW PARAMETERS
INTAKE
DUCT NO 1 - 762 mm STEEL PIPE, 430 m LONG
DUCT NO 2 - 915 mm CEMENT LINED STEEL PIPE, 430 m LONG
NO 2
- 23 m WATER HEAD
MICROSTRAINERS BYPASS LINE
TRAVELLING WATER SCREEN
- ONE AUTOMATICALLY CLEANED SCREEN
- SCREEN HAS BRASS MESH WITH 3 mm SQUARE OPENINGS
LOW LIFT PUMPING STATION
NO. TYPE CAPACITY
1 ELECTRIC 32.7 ML/d
1 ELECTRIC 41.8 ML/d
1 DIESEL 22.3 ML/d
TOTAL 101.8 ML/d
FIRM 60.0 ML/d
MICROSTRAINING
- 4 MICROSTRAINERS WITH 9.7 ML/d CAPACITY EACH
- NOMINAL SIZE 2.13 m DIAM x 1.53 m LONG
- STAINLESS STEEL MESH, 35 um OPENINGS
WASTE TO BAY OF QUINTE
ALUM
- 2 27 280 L STEEL STORAGE TANKS FOR LIQUID ALUM
- 1 TANK WITH PVC LINER, 1 WITH WOUND RUBBER LINER
- 2 METERING PUMPS, FLOW PACED ON RAW WATER
- DOSAGE RANGE: 22-57 mg/L
- EQUIPMENT CAPACITY: 0-263 mg/L
FLUORIDE
- 1 18 180 L STEEL STORAGE TANK WITH WOUND RUBBER LINER FOR HYDROFLUOSILICIC ACID
- 1 METERING PUMP, FLOW PACED ON RAW WATER
- DOSAGE RANGE: 0.9-1.5 mg/L
- EQUIPMENT CAPACITY: 0-2.0 mg/L
PRECHLORINATION
- 1 905 kg/d PRECHLORINATOR
- 1 905 kg/d PRE OR POSTCHLORINATOR
- FLOW PACED ON RAW WATER FLOW
- DOSAGE RANGE: 2.3 - 5.3 mg/L
- EQUIPMENT CAPACITY: 0-33.5 mg/L
FLOCCULATION
TANKS 1-18 - 3 SETS OF 6 CELLS EACH
- NOMINAL SIZE 2.33 m x 2.82 m x 4.30 m DEEP
- DETENTION TIME AT 27 ML/d = 32 MIN
TANKS 18-26 - 4 SETS OF 2 CELLS EACH
- NOMINAL SIZE 3.71 m x 3.71 m x 5.33 m DEEP
- DETENTION TIME AT 27 ML/d = 31 MIN
SETTLING TANKS
HORIZONTAL, CROSS FLOW SETTLING TANKS
TANKS 1-3 - NOMINAL SIZE 22.3 m x 7.62 m x 5.41 m DEEP
- OVERFLOW RATE AT 27 ML/d = 2.2 m/h
- DETENTION TIME AT 27 ML/d = 147 MIN
TANKS 4-5 - NOMINAL SIZE 35.1 m x 7.2 m x 4.7 m DEEP
- OVERFLOW RATE AT 27 ML/d = 2.2 m/h
- DETENTION TIME AT 27 ML/d = 127 MIN
SLUDGE TO BAY OF QUINTE
FILTERS
FILTERS 1-8 - NOMINAL SIZE 7.0 m x 5.5 m
- FILTRATION RATE AT 8.75 ML/d PER FILTER = 7.3 m/h
- DUAL MEDIA WITH 305 mm ANTHRACITE, 460 mm SAND AND 460 mm GRAVEL
- FILTERS 1-6, HAVE 100 mm DIAMETER CAST IRON LATERAL UNDERDRAINS
- FILTERS 7-8, HAVE LEOPOLD BLOCK UNDERDRAINS
BACKWASH TO BAY OF QUINTE
POSTCHLORINATION
- 1 905 kg/d PRE OR POSTCHLORINATOR
- NOT PRESENTLY USED
CLEARWELL AND RESERVOIR
1 CLEARWELL CAPACITY = 1.14 ML
1 RESERVOIR CAPACITY = 4.45 ML
TOTAL 5.59 ML
BACKWASHING
- ELEVATED BACKWASH TANK
- METERED ELEVATED TANK, CAPACITY 181 800 L
- 8.5 ML/d PUMP USED TO FILL TANK
HIGHLIFT PUMPING STATION
HIGHLIFT PUMPS
NO. TYPE YEAR CAPACITY TOTAL DYNAMIC HEAD
4 ELECTRIC 1960 13.0 ML/d EACH 68.6 m
1 DIESEL 1960 13.0 ML/d 68.6 m
1 DIESEL 1950 13.0 ML/d 63.1 m
TOTAL 95.6 ML/d
FIRM 78.5 ML/d
TO DISTRIBUTION SYSTEM
BELLEVILLE WTP
BLOCK FLOW DIAGRAM
JUNE, 1987



SITE PLAN



LOCATION PLAN

NOTES	CHECKED	Gore & Storrie Limited	SITE & LOCATION PLAN	BELLEVILLE UTILITIES COMMISSION WATER PURIFICATION PLANT
RECORD DRAWING				Gore & Storrie Limited G&S Consulting Engineers & Architect DATE MAY 1987 FILE No SCALE AS NOTED DRAWING No

TERMS OF REFERENCE

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive a package of available information on the plant from the MOE. Review the information provided and meet with the MOE staff to discuss the project.

2. Document the quality and quantity of raw and treated waters. Along with Work Task 3, send a progress report to the Project Committee at the conclusion of this work.

3. Define the present treatment processes and operating procedures. Along with Work Task 2, send a progress report to the Project Committee at the conclusion of this work.

4. Assess methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant. Along with Work Task 5, send a progress report to the Project Committee at the conclusion of this work.

5. Assess methods which would improve, if necessary, the disinfection practices of the plant, keeping in mind a desire to minimize the production of chlorinated by-products in the treated water. Along with Work Task 4, send a progress report to the Project Committee at the conclusion of this work.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal, with emphasis on particulate removal and a desire to minimize the production of chlorinated by-products. Meet with the Project Committee at the conclusion of this work to review the report information.

7. Prepare 7 copies of the draft report and submit to the Project Committee.

8. Review the Project Committee's comments and prepare 25 copies of the final report.

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 1

---

1. RECEIVE A PACKAGE OF AVAILABLE INFORMATION ON THE PLANT FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF TO DISCUSS THE PROJECT.

Elements of Work

(a) Receive a package of available information from the MOE concerning the plant.

(b) Review the information and otherwise prepare for a meeting to initiate work on the project, including preparation of a schedule of manpower and staff requirements.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule.

2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS. ALONG WITH WORK TASK 3, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Tabulate the daily raw and treated water flows for the last three consecutive years.

(b) Document the methods of measuring the raw and treated water flow rates, and assess the validity of the records.

(c) Prepare a monthly summary of maximum, minimum, and average flows for the three years. Address any discrepancies which exist between raw and treated flow rates.

(d) Review and assess the monthly maximum, minimum, and average per capita flow for the three years. Compare the plant data with typical per capita flows for the local region.

(e) Document a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information. Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show corresponding sets of raw and treated water quality information. Document the source and methods used in determining all water quality information. Assess the validity of the data, comparing plant and outside laboratory data.

(f) Tabulate, for the last three consecutive years, where available, raw and treated water turbidity, residual aluminum, pH, and colour. Record other data, such as particle counting, suspended solids, and algae counting, which could reflect on particulate removal efficiency. These data should be used for assessment of the particulate removal efficiency of the plant. Document the source and methods used in determining all information. A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(g) Tabulate, for the last three consecutive years, the raw water bacterial test information at the plant. Also tabulate the corresponding treated water tests at the plant which register positive results. Document the source and methods used for all data provided. This information should be used to assess the effectiveness of the disinfection practices at the plant.

(h) Identify and recommend other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

(i) Submit a progress report to the Project Committee.

WATER PLANT OPTIMIZATION STUDY
PLANT INVESTIGATION AND PROCESS EVALUATION STUDY
TERMS OF REFERENCE - WORK TASK NO. 3

---

3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. ALONG WITH WORK TASK 2, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSIONS OF THIS WORK.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings, of a reduced size, to document the general site layout and the interrelationship of major plant components. If not already available, prepare a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of the major plant components.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems.

(d) Tabulate the design parameters for all of the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the DWSP Questionnaire and must be confirmed and verified by field observations.

(e) Prepare a brief summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document and assess any reported problems in plant operations and/or in the distribution system related to water quality.

(g) Tabulate the daily average chemical dosages for the last three consecutive years. Document the methods used to evaluate chemical dosages and establish the validity of the dosage information provided.

With regard to disinfection, tabulate the dosages of chlorine and disinfection-related chemicals such as chlorine dioxide. In addition, provide corresponding data on disinfectant residuals in the plant, such as free and total chlorine residuals. Also, provide chlorine demand tests where available. Again, document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(h) Submit a progress report to the Project Committee.

4. ASSESS METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT. ALONG WITH WORK TASK 5, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using information provided in Work Tasks 1 and 2, evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 FTU, which is the maximum acceptable concentration of the Ontario Drinking Water Objectives (Table 1, page 2, Ontario Ministry of the Environment, Revised 1983). It should, however, be recognized that it is desirable to strive for an operational level which is as low a turbidity level as is achievable.

(b) Conduct an evaluation of possible optimum performance alternatives, including jar testing of plant water samples.

(c) Evaluate the feasibility of optimum removals using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(d) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

(e) Report to the Project Committee.

5. ASSESS METHODS WHICH WOULD IMPROVE, IF NECESSARY, THE DISINFECTION PRACTICES OF THE PLANT, KEEPING IN MIND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS IN THE TREATED WATER. ALONG WITH WORK TASK 4, SEND A PROGRESS REPORT TO THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK.

Elements of Work

(a) Using the information provided in Work Tasks 1 and 2, evaluate the plant's ability to disinfect the water. The basis of minimum disinfection should be to ensure a water quality as described in the Ontario Drinking Water Objectives (Ontario Ministry of the Environment, Revised 1983).

(b) Conduct an evaluation of possible optimum disinfection procedures for the plant, with consideration also given to the reduction of chlorinated by-products in the treated water.

(c) Evaluate the feasibility of the various alternatives using the existing plant capital works. Estimate the initial and final levels of chlorinated by-products for the various alternatives. Assess the relative merits of the alternatives.

(d) Describe the operational procedures, management strategies, and equipment required for the feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation for the alternatives.

(e) Report to the Project Committee.

6. DESCRIBE POSSIBLE SHORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM DISINFECTION AND CONTAMINANT REMOVAL, WITH EMPHASIS ON PARTICULATE REMOVAL AND A DESIRE TO MINIMIZE THE PRODUCTION OF CHLORINATED BY-PRODUCTS. MEET WITH THE PROJECT COMMITTEE AT THE CONCLUSION OF THIS WORK TO REVIEW THE REPORT INFORMATION.

Elements of Work

(a) It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost for each of the proposed modifications.

(b) Prepare a schedule for the list of modifications.

(c) Meet with the Project Committee at the plant site to review the proposed modifications.

7. PREPARE 7 COPIES OF THE DRAFT REPORT AND SUBMIT TO THE PROJECT COMMITTEE.

Elements of Work

(a) The report must include all the information reported previously in the study. The information must be organized and presented in a logical and co-ordinated fashion.

A general table of contents will be provided for organizing the material in a manner consistent with other plant reports.

(b) Submit the draft report to the Project Committee for review.

(c) Prepare a separate letter report containing a recommendation(s) concerning the need for additional field testing to cover water quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

8. REVIEW THE PROJECT COMMITTEE'S COMMENTS AND PREPARE 25 COPIES OF THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implications of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit copies of the final reports to the MOE for distribution.